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A  
HOMEOPATHIC  
TEXT-BOOK  
OF  
SURGERY

BOSTON UNIVERSITY  
School of Medicine

EDITED BY

*Thomas*  
CHARLES E. FISHER, M. D., CHICAGO

AND

T. L. MACDONALD, M. D., WASHINGTON

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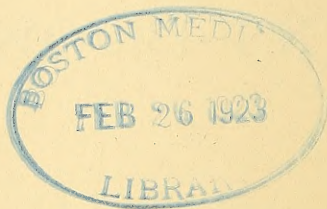
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CHARLES E. FISHER

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# AUTHORS AND SUBJECTS.

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- ADAMS, CHARLES, M. D., F. R. M. S., Chicago; Professor Principles and Practice of Surgery Chicago Homeopathic Medical College, Surgeon to Cook County Hospital, Chicago Homeopathic Hospital, Chicago Nursery and Half Orphan Asylum and First Regiment Illinois National Guard.....GUN-SHOT SURGERY.
- BEEBE, CURTIS M., M. D., Chicago; Professor Surgery National Medical College, Surgeon to Cook County Hospital.....MINOR SURGERY.
- BISHOP, WILLIAM H., M. D., New York; Lecturer on Surgery New York Homeopathic Medical College, Adjunct Professor of Surgery Metropolitan Post-Graduate School of Medicine and Surgery, Surgeon Flower Surgical Hospital.....  
FRACTURES AND DISLOCATIONS.
- CHISLETT, HOWARD ROY, M. D., Chicago; Professor of Surgery and Clinical Surgery Hahnemann Medical College and Hospital, Attending Surgeon to Cook County Hospital.....  
SURGICAL BACTERIOLOGY AND SURGERY OF THE JOINTS.
- EMERSON, NATHANIEL W., M. D., Boston; Assistant Professor of Surgery Boston University School of Medicine.....MODERN SURGICAL TECHNIQUE.
- FISHER, CHARLES E., M. D., Chicago; Professor of Surgery Hering Medical College, Surgeon to Hering Homeopathic Hospital.....  
SURGICAL DISEASES, BURNS AND SCALDS.
- GREEN, W. E., M. D., Little Rock, Arkansas.....  
SURGERY OF THE DIGESTIVE SYSTEM.
- HELMUTH, WM. TOD, A. M., M. D., LL. D., New York; Professor of Surgery New York Homeopathic Medical College, Consulting Surgeon to Laura Franklin Free Hospital for Children, and Flower Surgical Hospital, and to the New York Medical College and Hospital for Women.....TUMORS.
- JAMES, JOHN E., A. M., M. D., Philadelphia; Surgeon to Hahnemann Hospital, Consulting Surgeon to Children's Homeopathic Hospital of Philadelphia, late Senior Professor of Surgery Hahnemann Medical College.....AMPUTATIONS.
- KING, WM. R., M. D., Washington, D. C.; Ophthalmologist and Otologist to National Homeopathic Hospital, Washington; Professor of Ophthalmology Southern Homeopathic Medical College, Baltimore.....SURGERY OF THE EAR.
- LAIDLAW, GEORGE FREDERICK, M. D., New York; Lecturer on Pathology New York Homeopathic Medical College and Hospital, Adjunct Professor of Pathology New York Post-Graduate School of Medicine, Pathologist to New York Ophthalmic Hospital.....LABORATORY TECHNIQUE.
- LEE, J. M., M. D., Rochester; Surgeon to Rochester Homeopathic Hospital.....  
SURGERY OF THE PERITONEUM, LIVER AND PANCREAS, SURGERY OF THE UTERUS.



- MACDONALD, T. L., M. D.; Professor of Surgery Southern Homeopathic Medical College, Baltimore; General and Gynecological Surgeon National Homeopathic Hospital, Washington.....  
SURGICAL ANESTHESIA, SURGICAL SHOCK, ASEPSIS AND ANTISEPSIS, SURGERY OF THE SPINE, CORD AND NERVES, SURGERY OF THE KIDNEYS AND URETERS, SURGERY OF THE TUBES AND OVARIES.
- MORGAN, W. B., A. M., M. D., PH. D., St. Louis; Professor of Surgery Homeopathic Medical College of Missouri.....  
SURGERY OF THE VASCULAR SYSTEM, SURGERY OF THE GLANDULAR SYSTEM, SURGERY OF THE MALE GENITO-URINARY ORGANS.
- PALMER, GEO. H., M. D., Professor of Surgery Hahnemann Hospital College, San Francisco..... WOUNDS.
- PARSONS, S. B., M. D., St. Louis; Ex-Professor Surgery Homeopathic Medical College, Surgeon to Good Samaritan Hospital..... PLASTIC SURGERY.
- PRATT, E. H., A. M., M. D., LL. D., Chicago; Professor of Orificial Surgery Chicago Homeopathic College, Consulting Surgeon Cook County Hospital.....  
SURGERY OF THE LOWER ORIFICES OF THE BODY.
- ROBERTS, G. W., M. D., New York; Attending Surgeon Laura Franklin Hospital, Adjunct Professor of Surgery Metropolitan Post-Graduate School of Medicine, Lecturer on Orthopedic and Minor Surgery New York College and Hospital for Women..... SYPHILIS.
- SANDERS, J. KENT, A. M., M. D., Cleveland; Professor Surgery Cleveland University of Medicine, Surgeon to Huron Street Hospital.....  
SURGERY OF THE RESPIRATORY SYSTEM.
- SHEARS, GEORGE F., M. D., Chicago; Senior Professor of the Principles and Practice of Surgery in the Hahnemann Medical College of Chicago, Senior Surgeon to Hahnemann Hospital..... HERNIA AND SURGERY OF THE BREAST.
- VAN LENNEP, WM. B., A. M., M. D., Philadelphia; Professor of Surgery Hahnemann Medical College, Senior Surgeon to Hahnemann Hospital.....  
SURGICAL DISEASES AND INJURIES OF THE HEAD.
- WALTON, CHARLES E., A. M., M. D., Cincinnati; Professor of Operative and Clinical Surgery Pulte Medical College..... LIGATION OF ARTERIES.
- WILCOX, DE WITT G., M. D., Buffalo; Visiting Surgeon to Erie County and Buffalo Homeopathic Hospitals, Surgeon to Lexington Heights Hospital.....  
SURGERY OF THE OSSEOUS SYSTEM.
- WILCOX, SIDNEY F., M. D., New York; Professor of Surgery New York Medical College and Hospital for Women; Professor Principles of Surgery and Lecturer on Orthopedic and Rectal Surgery New York Homeopathic Medical College and Hospital, Surgeon to Flower Surgical Hospital, Surgeon to Laura Franklin Free Hospital for Children, Consulting Surgeon to New York Hospital for Women and Children, Brooklyn..... ORTHOPEDIC SURGERY.
- WILSON, HAROLD, M. D., Detroit; Ophthalmic and Aural Surgeon to Grace Hospital, Oculist to Protestant Orphan Asylum of Detroit.....  
SURGERY OF THE EYE.



# PREFACE.

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The present volume is one of the logical results of the revolution that has been taking place in surgery in recent years whereby a new surgical literature has been made necessary, and of the exceedingly satisfactory development of surgical ambitions and successes among members of the homeopathic profession. While a number of text-books have lately been issued to meet the demand of the new order in the chirurgic art, in none has been outlined the application of remedial agents to surgical diseases and states according to the law of cure enunciated by Hahnemann—a law which a century of experience has amply demonstrated to be a most satisfactory principle of practice—and it is in part the function of this volume to remedy this defect. Not only has this result been in good measure accomplished but it is believed, also, that the book will not be found to be deficient in any important surgical particular, it having been the aim to make it thoroughly representative of the surgery of the closing years of the nineteenth century, as well as to give substantial expression to the hope that the homeopathic profession may be absolved from the necessity of depending upon alien talent for a surgical literature. To just what extent the authors and editors have been able to realize these ambitions those for whom the book has been constructed must determine.

As will be seen by reference to the corps of authors, above a score of homeopathy's surgeons have been enlisted in the preparation of the volume. In many instances the task has been onerous, yet each collaborator has performed the duty assigned him with fidelity to the trust imposed, and thus has been secured a treatise which faithfully reflects the practices of the surgeon-clinicians of the homeopathic profession of the United States. As such the volume is submitted to that profession in the confident hope that it will meet with cordial welcome as an exponent of modern surgery plus the application of the law of similars to surgical diseases and conditions in which medication is helpful and demanded.

The most painstaking care has been exercised by authors and editors alike to make the text original and concise yet sufficiently comprehensive to clearly elucidate the subjects treated. Necessarily, as in all composite works, there has been some repetition, and, on the other hand, in a few instances individual topics have been somewhat abbreviated in order to abridge an already large volume. It being the expectation that the book



will be depended upon by surgeons and students in remote fields, special sections on Laboratory Technique, Modern Surgical Technique, the Surgery of the Eye and the Surgery of the Ear, subjects not properly belonging to a purely practical text-book on operative surgery, have been added. These enlarge the scope of the work beyond the original intention and swell its pages, but their addition will, doubtless, enhance the value of the book, especially to students and beginners.

The greatest possible degree of liberty has been allowed individual authors in the expression of their views in relation to medicinal and auxiliary measures and treatments, the editors disclaiming responsibility for views not in strict accord with the homeopathic law of drug application.

It is with satisfaction and pleasure that the announcement is made that Prof. Wm. Tod Helmuth, of New York, whose "System of Surgery" was the pioneer volume in surgical literature by a homeopathic author, and which for many years has served a most excellent purpose, is associated with the staff of contributors to this volume, and has given up the issuance of a sixth edition of his work, thus making the Text-Book the sole exemplar of the surgery of its profession. If it be found to be possessed of shortcomings an earnest endeavor will be made in subsequent editions to overcome whatever of dereliction the present edition may reveal.

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JANUARY, 1896.

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# A HOMEOPATHIC TEXT-BOOK OF SURGERY

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## SECTION I.

### SURGICAL BACTERIOLOGY.

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#### CHAPTER I.

#### GENERAL BACTERIOLOGICAL CONSIDERATIONS.

---

**Essential Features.**—The essential features of bacteriology are the practical points which have a direct bearing upon surgical practice, which will enable the reader to more readily appreciate the necessity of thoroughness in carrying out the details of modern surgery, and which will render repeated explanations unnecessary when we come to treat of the infective forms of surgical disease. The methods of cultivation and of staining are intentionally omitted. Such subjects, as well as inoculation experiments, belong to the bacteriologist rather than to the surgeon.

From a practical standpoint all micro-organisms may be divided into two great classes: First, the non-pathogenic bacteria, or saprophytes, which in their native state live and multiply in organic matter which is already dead, and, accordingly, are not disease-producing germs. Second, the pathogenic bacteria, or parasites, which under favorable conditions develop in and upon living tissues, producing in them those changes from the normal which are termed diseases. It is interesting to note, in passing, that by cultivation saprophytes may become pathogenic, and that many of the true parasites are able to live and perhaps to multiply independent of animal life. These are then termed facultative.

**Forms.**—The two forms of pathogenic bacteria which play the most important parts in the causation of surgical disease are the bacillus, or rod-shaped bacterium, and the coccus, or ball-shaped one. There are many varieties of both of these forms, the most important of which will be described later. For the present, however, it will suffice to state that they have different methods of grouping themselves and of attacking the tissues, and it is mainly by these peculiarities that we distinguish between the different members of the same family. There are very few places where enthusiastic scientists have failed to discover micro-organisms of



both families. An interesting feature is that pathogenic bacteria increase in number and virulence in proportion to the population, and so are more abundant in cities than in towns, and especially in those city districts where proper ventilation of houses is as much of a rarity as a good bath for the inhabitants. It is in such quarters that disease gains its foot-hold and that the most stringent measures of disinfection and antisepsis are necessary to insure good results. Bacteria exist in the air and upon all objects exposed to it; in the water, especially surface water and those wells and reservoirs within reach of contamination from imperfect drainage systems; and in the soil, particularly in superficial soils containing an abundance of decaying organic matter and moisture. The essentials for their growth and multiplication are heat, moisture and food.

**HEAT.** By heat is meant a temperature between 40 and 112 degrees F. Above and below these extremes reproduction of parasites ceases, but it requires much greater extremes to actually destroy life, the germs, and especially their spores, often living for a long time, even when exposed to most unfavorable conditions. Boiling will destroy all germs which are not spore-bearing.

**MOISTURE.** This is another essential element, serving as the conducting medium both of food and of oxygen. It is a well-known fact that organic matter can be preserved indefinitely if all moisture be extracted. Thorough drying destroys many of the pathogenic bacteria as well as those of putrefaction.

**FOOD.** Bacteria are epicures. Each variety has a special food upon which it thrives best. Where there is mixed infection slight differences in the chemical composition of tissues, whether natural or changed by the products of bacterial life, favor the localization and development of one form in preference to another. Those bacterial diseases which are self-limited are probably so as the result of the formation of ptomaines which are inimical to the bacterial life, or as the result of the germs having exhausted the tissues of their necessary food. Most pathogenic bacteria thrive best on alkaline foods and many are inert in acid media.

**Localization.**—The fact that the bacteria are so wide-spread and the conditions for their reproduction so prevalent is apt to carry purely scientific minds beyond the border lines of reason, and to force upon them many ideas that are not practical and not borne out by surgical experience. What is meant is that if we gave credence to all the injunctions of the bacteriologist we would lose one-half of our power as surgeons through fear of exposure of our patients. The facts are that pathogenic bacteria do not rapidly multiply away from the animal body, and that even though cultures may be made from any objects which have been exposed to the air or any ordinary waters the germs in them do not exist in sufficient numbers to invade and conquer animal tissues of ordinary health. In other words, the danger of exposure of wounds to ordinary clear atmospheres, or the washing of them with water which would be thought clean enough to drink, is practically nothing, the average tissues being abundantly able to cope with the germs thus gaining entrance. Where we most expect danger, and most strongly protect against it, is from the germs that exist in and upon the body of the patient, especially about the seat of the operation, and upon the bodies of the surgeon and his assistants.

Bacteria exist in the body both in health and disease. They are most numerous on exposed parts and especially those parts supplied freely with glandular structures to furnish the essential moisture. Thus, the scalp, the axilla, the perineal region and especially the hands and feet are localities fairly teeming with virulent micro-organisms. The clinical point is that those parts where natural excretions are retained, devitalizing the superficial cells and furnishing every inducement for the development of germs, are the parts where most thorough disinfection is necessary prior to operative procedures. Bacteria exist also on the mucous membranes, both of the respiratory and alimentary tracts. In the former they are drawn in at each inspiration, but the bronchial mucous membranes seem to act as a sort of filter, the germs reaching the air cells only in small quantities. This applies to ordinary states of health; in infective diseases of the mouth or tongue septic pneumonia is not an uncommon sequel. Bacteria are found, also, in almost every variety, in the alimentary canal, more especially in the intestines than in the stomach, the acid secretion of the latter serving to inhibit their growth. It is now generally conceded that micro-organisms in considerable quantities find their way into the circulating blood, and thus into the tissues, by passing through the mucous membrane of the alimentary and respiratory tracts. It is a fact that they are quite harmless in ordinary conditions of health, the blood-serum serving as the active agent for their destruction, the leucocytes for their elimination. Given, this condition of circulating micro-organisms in tissues in which the normal power of resistance has been markedly lessened and even slight circulatory disturbances may be sufficient to cause their arrest and development; this offers a rational explanation for the development of suppurative inflammations after very slight traumatism without abrasion, or from the chilling of a part. It should be impressed upon the mind most forcibly that though it is a possibility for wound infection to occur from the side of the tissues it occurs so seldom that we may say, practically, it never takes place.

**Traumatism.**—The great essential to the localization and development of germs is a diminished vitality on the part of the tissues with which they are brought in contact. This diminished resistance may be due to injury or disease. By far the most important factor of localization in surgical diseases is traumatism—most important because most common.

Traumatism may cause localization in one of three ways: First, by an abrasion of the surface and the direct introduction of the microbes. Second, by a subcutaneous hemorrhage, the micro-organisms in the blood escaping into the tissues in the extravasation. Third, by setting up a traumatic inflammation in the exudate of which the microbes find a soil exactly suited to their development. In this way a simple inflammation may become an infective one; there is the partly devitalized tissue, the heat, the moisture—and the stasis gives the only other essential, time.

Besides traumatism local depressions may arise in previously diseased parts, either from mechanical obstruction to venous circulation or from chilling, the change in the circulation lasting sufficiently long for the germs to gain a strong foot-hold.

**Multiplication.**—When once fairly located bacteria multiply very rapidly, the reproduction taking place in two ways: First, by segmentation or binary division, and, second, by spores.

**SEGMENTATION.** In the bacilli segmentation takes place only at right angles to the long axis. In the cocci it may be in any direction and the new formations may at once separate, forming distinct cells—monococcus; they may remain in couplets—diplococcus; may gather about in groups resembling bunches of grapes—staphylococcus; or extend into long chains—streptococcus. The time required for the segmentation is variously estimated at from ten to thirty minutes; the newly formed cells rapidly enlarge and then undergo a like division.

**SPORULATION.** Multiplication by spores, called sporulation, has not yet been determined in cocci. It is frequently seen in bacilli, and in some forms segmentation and sporulation go on at the same time. The main point of practical interest to the surgeon is that in their development spores become surrounded by a firm, stout membrane, which renders them so much more resistant than the fully developed germs that much greater extremes of either heat or cold are required to destroy them. Another fact of importance is that they may lie dormant in the tissues almost indefinitely, requiring only slight encouragement to develop.

**EFFECTS.** In their development and multiplication bacteria affect the body both in a local and general way. The local effects vary from simple irritation to inflammation, depending upon the duration of the action. The inflammatory changes are brought about by the direct action of the bacteria, which have the power of taking from the tissues certain elements which are essential to their healthy action. In the decomposition of the tissues by the micro-organisms certain soluble toxic alkaloids, known collectively as ptomaines, are found. It is the formation and absorption of these ptomaines or toxines which produce the general effects.

The different forms of bacteria differ greatly in their method of attacking the tissues after they have once gained a foot-hold. There are three ways in which they may spread: First, by continuity of structure. Second, by the lymphatic spaces and vessels. Third, by the blood vessels.

Those which spread by continuity of structure are, as a rule, slow in action, remaining about the seat of inoculation until strictly limited by the efforts of nature, i. e. by cell proliferation. Those forms which choose lymph spaces usually enter the vessels, spread rapidly and involve the nearest glands. Here they are arrested for a time, but if the disease is active the glands of a group are invaded one by one until they are all involved, and then systemic trouble is imminent.

Others enter the blood current directly and either become at once destroyed or develop in the vessel wall, soon causing the formation of an infective thrombus. Part of a softening thrombus is liable to detachment, thus giving rise to an embolism. This becoming arrested in another part gives a new focus for development. Nature unaided has two ways of limiting this tendency to spread. It is a fact proved both clinically and experimentally that the serum of circulating blood is one of the best germicides. There is little reason to doubt the theory that the fixed cells in the different organs and tissues also act as destructive agents of the bacteria. This process is termed by Metchnikoff phagocytosis, the cells being known as phagocytes. The outcome of the battle depends upon the number and virulence of the microbes on one hand and the general health of the patient and the activity of the special parts involved on the other.



When the serum of the blood and the phagocytes are inefficient in causing the destruction of the germs the system has still one means of freeing itself from their influence—the excretory organs. The organs most active in this elimination are the kidneys and the mucous membrane of the intestines. In the intense activity of both, so often seen in infective diseases, it is well to watch for the development in them of pathological conditions induced either by excessive activity, prolonged by the irritant action of the ptomaines, or by secondary infections from the micro-organisms themselves. The skin and the salivary glands are occasionally active agents of elimination.

The system can be aided in its fight against the enemy in two ways: First, by increasing the natural strength of the patient by the use of good nourishing food and plenty of fresh air, plenty of water internally, to stimulate all the excretory organs, and externally, for absolute cleanliness, to prevent blocking the cutaneous exit for the poison. Second, by changing the nature of the bacteria and weakening their special toxins or rendering the tissues an unfit place for development. This second method includes the use of antiseptics, both local and general, and chemical agents known to possess qualities antidotal to toxic effects. It is unfortunate that experience has demonstrated that antiseptics which have a decided influence outside of the body cannot be used in sufficient strength to prove effective within.

The field which has been thus far less tried but which offers the grandest chance of success is therapeutic inoculation. It is a well known fact that the chemical products formed by the action of some bacteria on the tissues are inimical to the bacteria themselves, and that in mixed infections some species are direct antidotes to others; these facts are the keynotes of therapeutic inoculation. This science is yet in its infancy, but in the light of recent investigations there is now believed to be little doubt that gradually increasing doses of these chemicals which have been carefully separated from the true germs will secure immunity from disease in man as they have done in lower animals.

**Special Microbes.**—Let us now take a brief view of the characteristics of some of the special microbes.

**STAPHYLOCOCCUS PYOGENES AUREUS.** This is the most common of the pus microbes and is found almost uniformly in acute suppurative inflammations, either alone or combined with some of the other forms. Its more common name is the golden-grape coccus, from the facts that in its development it forms masses like a bunch of grapes and in the presence of oxygen gives rise to a golden-yellow pigment. This is a facultative parasite; that is, it finds conditions suitable for its development out-side of the body as well as within. It has been



FIG 1  
STAPHYLOCOCCUS  
PYOGENES  
AUREUS. (STICK)



found on all parts of the human body, both of the skin and of the surface mucous membranes. The causative relationship of this germ to suppurative inflammations has been frequently demonstrated by inoculation experiments, both in man and in animals. It multiplies rapidly at a temperature even as low as 65 degrees F., though the heat most favorable to its rapid reproduction is between 95 and 100 degrees F. Extreme cold has no destructive influence, simply retarding reproduction. The thermal death-point in moist fresh cultures is, according to Sternberg, between 132.8 degrees F. and 136.4 F. At this temperature the exposure required is ten minutes. When desiccated it maintains its virulence for ten days, (Passet), and in this condition is destroyed only after an exposure to a temperature of from 195 to 212 degrees F. A five per cent. carbolic acid or a 1-1000 solution of mercuric bichloride will destroy vitality in from a few seconds to ten minutes, depending upon the virulence of the colony.

**STAPHYLOCOCCUS PYOGENES ALBUS.** In development, multiplication and microscopic appearance this form is identical with the yellow-grape coccus with which it is frequently associated. It differs in its lesser virulency, liquifying gelatin much more slowly, and in its absence of pigment. Recent investigators claim that it is a constant inhabitant of the deeper layers of the epidermis where ordinary methods of surgical sterilization are ineffectual. It has also been found in recent wounds when healing without suppuration. The explanation must be found in either the small number or in the slowness of the reproductive power. Clinically this microbe is found most frequently combined with other pyogenic cocci in acute abscesses, a fact well explained by its location in the epidermic layer. It is restricted or assisted by the same temperatures as the staphylococcus aureus and is destroyed by the same chemical agents.

**STREPTOCOCCUS PYOGENES.** This is also a facultative parasite named streptococcus from the tendency to form in chains, owing to its multiplication by binary division in one direction only. It will develop either with or without oxygen, and most rapidly at a temperature between 80 and 100 degrees F. Maintained at such a temperature cultures in gelatin reach their full development in four days. The white granular column with its irregular culture is nicely illustrated in Figure 3. It is unlike the preceding forms in that it does not liquify the medium. The question whether this microorganism is identical with the streptococcus erysipelatis is still hotly disputed. That they show apparently the same in cultures is generally conceded, but the consensus of opinion seems to be with Fehleisen that both in accidental and experimental inoculations they act differently upon the tissues. This difference is



FIG 2.  
STREPTOCOCCUS  
PYOGENES.

pointed out in the article on phlegmonous erysipelas. Clinically we find the streptococcus pyogenes most frequently either singly or in combination in suppurations which are diffused.

Opinions of different observers regarding the thermal death-point of this micro-organism are very conflicting. Passet affirms that they will withstand the temperature of boiling water, but other authors assert that an exposure for ten minutes to a temperature of even 125 degrees is sufficient to destroy their vitality. Bichloride of mercury 1-1000 and carbolic acid 1-300 will destroy them in a few seconds.

The micrococcus pyogenes tenuis, the bacillus fetidus, the bacillus pyocyaneus, the staphylococcus cereus, and citreus albus and flavus are not sufficiently important to the surgeon to demand especial attention. They are very infrequently seen clinically, and their causative relationship to suppuration is still questionable. The bacillus pyocyaneus is simply a chromogenic microbe found only occasionally in open wounds which are suppurating.

**GNOCOCCUS.** The micrococcus of gonorrhea is a strict parasite, develops only in the presence of oxygen, and is usually found as a diplococcus inhabiting the pus cells. The individual cells are not strictly round, the approximated surfaces being concaved, thus giving them a biscuit shape. Pure cultures can be obtained, according to Bumm, only in blood-serum. The development is very slow, and ceases below 77 degrees F. and above 100 degrees F. As these micro-organisms can only develop in the presence of oxygen the metastatic inflammations occurring during a specific urethritis are generally recognized as a result of a mixed infection from the presence of more common forms of pus germs. The gonococcus is destroyed in ten minutes by a temperature of 140 degrees, and the infectious nature of the discharges is destroyed by desiccation.

A discussion of the parts played by specific germs in causation of suppuration occurring during attacks of typhoid fever, pneumonia, diphtheria and scarlet fever has no place in a book of this kind. For mention of the bacillus coli communis see page 9.

**STREPTOCOCCUS ERYSIPELATIS.** As before stated this microbe is regarded by many as identical with the streptococcus pyogenes. If true, the clinical differences must be explained by the greater attenuation of the virus as well as the method of inoculation. Passet, the strongest upholder of their identity, debates upon their ability to withstand boiling water, while Sternberg, who also classifies them together, asserts that the micro-organisms are destroyed in ten minutes by a temperature of 125 degrees F. Simon, on the other hand, speaking of the streptococcus of erysipelas, says a temperature of 104 to 105 degrees F. maintained for two days is destructive. Clinically we know that erysipelas is frequently self-limited, and that it is seldom



FIG. 3.  
STAPHYLOCOCCUS  
PYOGENES  
AUREUS (STREAK)

attended by suppuration. Some authors, accepting Simon's experiments as to the effects of heat, credit the sudden cessation of symptoms in some cases of erysipelas to a destruction of the germs by the high temperature of the body. "After a few seconds' contact with 1-1000 corrosive sublimate, or a little longer with a 3 per cent. solution of carbolic acid, its vitality has gone." (Hamilton.)

**BACILLUS OF TUBERCULOSIS.** This is a true parasite in that it cannot multiply away from the animal body. In length it is about one-half the diameter of a red blood-corpuscle. Its causative relationship to the different forms of surgical tuberculosis has been proven by inoculation and cultivation experiments. It develops by spores most rapidly at a temperature between 98 and 100 degrees F. Recent investigators assert that sporulation has not been positively proven; the point of clinical interest is that these bacilli are as resistant as spore-bearing germs and that they may lie dormant indefinitely, encapsuled in the body. It is estimated that desiccated germs maintain their vitality for two and one-half months unless exposed to direct sunlight. This latter agent, according to Koch, destroys vitality in "from a few minutes to several hours, according to the thickness of the layer." Among the clinical agents used for their destruction Yersin cites the following: Five per cent. carbolic acid, thirty seconds; one per cent. of same in one minute; absolute alcohol five minutes; iodoform-ether one per cent. five minutes; mercuric bichloride 1-1000 one minute. Boiling from two to five minutes will destroy them.

**BACILLUS ANTHRACIS.** This is the largest known bacillus. It develops spores which form only in the oxygen. Reproduction which is most rapid at a temperature of the body ceases below 54 degrees F. and above 113 degrees F. Desiccation does not destroy their vitality or their virulence though they be preserved in this condition a long time. Spores thus dried require a dry heat of 284 degrees F. maintained for three hours to destroy them, but boiling will insure death in four minutes. In the absence of spores a one per cent. solution of carbolic acid will destroy the vitality, but spores require two days in a three per cent. solution to insure their destruction. A 1-1000 solution of bichloride of mercury will destroy them in a few minutes.

**BACILLUS TETANI.** The chief characteristic of this microbe is the development of a spore at the end of the rod, giving it the appearance of a pin. It is a product of the soil, developing by spores most rapidly at the temperature of the body. Reproduction ceases at 57 degrees F. and will not occur in the presence of oxygen. It is a micro-organism of great vitality. Desiccation has no effect upon the spores and they will withstand the usual chemical agents, five per cent. carbolic acid for fifteen hours and bichloride of mercury 1-1000 for two hours. Boiling for five minutes will destroy them. Ketasato has been able to assure immunity in animals by inoculations with the sterilized chemical products. The blood serum of an inoculated, immunized, animal also has the power of neutralizing the tetanus poison. This knowledge in so far as we can learn has not been taken advantage of clinically.

**BACILLUS MALLEI.** This is the bacillus of glanders and its causative relation is fully established. The germs are slightly curved, have rounded ends and require oxygen for their development. They multiply at



between 72 and 109 degrees F. and, according to Loeffler, reproduction ceases below and above these points. Desiccation does not kill, at least for some weeks, but an exposure to a heat of 131 degrees F. for ten minutes effectually destroys life. They are destroyed by a three to five per cent. solution of carbolic acid in five minutes and by a 1-5000 solution of corrosive sublimate in two minutes.

**BACILLUS COLI COMMUNIS.** The bacillus coli communis is common to cholera Asiatica. It was first found during the cholera epidemic in Naples in 1885. Its pyogenic properties are now fully recognized, it being well understood that it may be a cause of septic and suppurative processes. It is a short rod with rounded ends, and also appears in chains and pairs. Sometimes as many as half a dozen or more links or filaments are combined to form a chain. It is possessed of spores and fine cilia, stains with aniline dyes, and can be discolored by the Gram method. Colonies have two distinct forms, one an irregular film and the other a heaped up colony of ivory white appearance (Warren), without tendency to spread out.

The bacillus bears a close resemblance to the bacillus of typhoid fever, but turns blue litmus paper a red color, while the latter fails to show acid reaction. The coli communis also decomposes sugar, evolving considerable amount of gas in the so doing.

The bacillus coli communis is found in suppurative processes in the peritoneal cavity, and occasionally in bronchial secretions in patients dying of pathological processes involving the peritoneum (Livy). It has been seen in connection with fulminating appendicitis, and in other processes arising in the pelvic organs and peritoneum, especially when the intestines are the site of destructive inflammation. Just as the pneumococcus and bacillus typhosus set up pyogenic processes so may the coli communis do likewise. The surgeon is chiefly interested in this micro-organism because of its causative relation to septic states.

## CHAPTER II.

### INFLAMMATION.

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**Fundamental Considerations.**—In the light of present knowledge a brief yet comprehensive definition of inflammation is impossible. That an intelligent understanding of this most important subject may be obtained the first essential is that the following interesting facts relative to the normal circulation be kept in mind:—The quantity of blood in the healthy body is practically constant, and it is the function of the vaso-motor nerves to maintain that relationship between the heart and the blood vessels which is best suited to a good and even circulation. It must be remembered that the main forces of the circulation, the heart's action, the elasticity of the arteries, the contraction of the voluntary muscles and thoracic aspiration, all diminish as distance from the center increases. Each additional arterial branch, too, diminishes these forces, by increasing the resistance which must be overcome. It can thus be readily understood why the vascular changes which will be treated of are most frequently seen in the small arterioles, the capillaries and the fine venous radicals. In addition to the serous portion of circulating blood there are at least three solid bodies whose importance should be borne in mind: (a), the red or colored corpuscles; (b), the white corpuscles or leucocytes; (c), the hematoblasts or blood plates. For a long time it has been recognized that in normal circulating blood there is a difference in the rapidity as well as in the nature of the movements of these corpuscles. Experimental research has determined that these differences are not due to any vital action, but are purely physical in their nature. In his last set of experiments Prof. D. J. Hamilton used defibrinated blood in capillary tubes. By raising and lowering the specific gravity with the addition of a saline solution he watched the effect upon the relative position and rapidity of movement of the red and white globules. He found that their situation depended entirely upon the relationship between the specific gravity of the solid bodies and that of the liquid in which they were suspended. By regulating the specific gravity he could make the colored corpuscles float in any part of the stream. The more nearly he approached the normal specific gravity of the blood plasma the greater the tendency to separation of the white from the red globules, the latter tending to the central, the former to the peripheral portion of the stream. From these experiments, both in large and capillary tubes, the following deductions, which have a direct bearing upon the pathological conditions to be considered later, can be made. First, In normal circulating blood there are two distinct streams: The central or axial and the peripheral. Second, The axial stream, being exposed to much less friction, moves with far greater rapidity. Third, Being more nearly of the same specific gravity as the plasma the colored corpuscles are found almost exclusively in the axial stream while the leucocytes, being specifically lighter, are more abundant in the peripheral stream. Fourth, The hemato-

blasts in normal circulation move with the red globules in the axial stream but in the slowing of the blood current incident to inflammation, being specifically lighter, they are forced with the leucocytes into the peripheral zone. Fifth, The red corpuscles being easily suspended, and meeting with little resistance, glide smoothly and rapidly; the white corpuscles, owing to their situation in the current, move much more slowly and roll over and over as they come in contact with the vessel wall. Sixth, A certain rapidity in the flow of blood is absolutely necessary to keep the leucocytes circulating, and when from any cause the normal rapidity is diminished the leucocytes tend to accumulate in the peripheral zone, to adhere to the vessel walls and thus result in stagnation.

With these facts before us, and before taking up the subject of inflammation proper, let us pass in brief review some of the vascular disorders which may become diseased conditions if neglected or prolonged.

**Local Anemia.**—The first of these is local anemia or ischemia; a local deficiency of blood due to partial or complete closure of the supplying artery.

**CAUSES.** Diminished arterial supply may be brought about in three ways: By nervous irritation in which the vaso-motor constrictors induce contraction; by arterial disease such as atheroma, calcification and resulting thrombosis and embolism; and by mechanical pressure, as from an inflammatory exudate, from contracting cicatrices or from the pressure of developing tumors or of displaced parts.

**EFFECTS.** The effects, of course, depend largely upon the size of the artery, the location and the probability of anastomotic changes. The primary effects are always paleness and coldness of the part. The secondary are impaired nutrition and function, which, if prolonged, will result in either atrophy, fatty degeneration or necrosis. The general effects do not concern us, save the notation that when a large artery is occluded other vessels must dilate to accommodate the increased blood which they must necessarily carry to relieve the heart strain. This is brought about by the vaso-motor nerves and is termed compensatory hyperemia.

**Hyperemia.**—This condition, otherwise known as congestion, may be defined as an excess of blood in the locally dilated vessels. It is well to remember that while most modern authors class them together some still make a distinction between hyperemia and congestion, using the former to denote an increase in the blood supply which is transitory, the latter for one which is prolonged.

There are two varieties of hyperemia, active or arterial, and passive or venous.

**ACTIVE HYPEREMIA.** This is an increased activity in the circulation. The cause is always diminished arterial resistance, which may be brought about by mechanical means, such as excessive use, friction, heat, reaction from cold, etc., or by disturbance in the vaso-tonic action, the result either of direct or indirect irritation.

*Effects.* These are primary and secondary. The primary are evidenced in redness, heat, increased activity in function, throbbing and often pain.

The secondary effects may be permanent enlargement of the vessels, increased nutrition and consequent hypertrophy of the surrounding tissues.

**PASSIVE HYPEREMIA.** This is more commonly spoken of as venous



congestion, and is due to an obstruction of the venous return with a resultant dilated condition of the small veins and capillaries.

*Cause.* There may be dilation of venous radicals all over the body secondary to diseased conditions of the heart, lungs, liver, etc., but the local conditions which we refer to are most frequently brought about by mechanical pressure, such as constricting bands of clothing, pressure from tumors, exudations or from displaced organs.

*Effects.* Whatever the cause the effects are dilated veins and capillaries and a markedly slow blood current, which may result in one of five terminations, according to the extent of the obstruction. First, Transudation of serum. The greater the dilation of the vessels the weaker their walls become, and owing to increased pressure larger quantities of serum transude through the walls. For a time increased activity of the lymphatics compensates for faulty veins and carries away the serum, but after a time, as the venous walls become more and more disabled, this compensation becomes insufficient and the serum remains in the tissues producing edema. This transudation differs from the exudation of inflammation in having less albumen, in being of lower specific gravity and in showing little tendency to coagulate. Second, Hemorrhage. Continued malnutrition and distension soon produce so weakened a condition of the vessel wall that a sudden exertion may result in its rupture. At any rate, hemorrhage is a not infrequent result. Third, Fibroid induration. This change results from long continued pressure and consists in proliferation of the connective tissue elements which, encroaching upon the higher structures, result finally in their atrophy and impaired function. It is one of the most important sequences of prolonged venous congestion and should be borne in mind especially in the study of diseases of the glandular system. Fourth, Thrombosis. This is not an infrequent result, though it is of course secondary to the degenerative change of the endothelial cells of the intima. Time will not now be taken to describe it as it will be considered fully under diseases of vessels. Fifth, Necrosis. Death to the tissue results, of course, only when the obstruction is practically complete. One can readily understand how, from malnutrition and pressure effects, this might be brought about.

**Treatment.**—The treatment of these vascular disorders in the early stage is simply to find the cause and remove it where possible. Where this is impracticable the circulation is to be regulated as can best be done by mechanical and medicinal means, both of which will be described in dealing with inflammation. The secondary effects will be taken up separately in their proper places.

**Causes.**—Inflammation never arises without a cause or causes. These we may divide into predisposing and exciting.

**PREDISPOSING CAUSES.** The predisposition to inflammation, as to any other diseased condition, is a lessened power of resistance on the part of the tissues. This want of normal vital energy may be an hereditary taint or be acquired by disease or improper habits; it may be the result of insufficient or improper foods, the patient being poorly nourished; or, lastly, it may be because of abnormal physical surroundings, such as poor hygienic conditions, prolonged exposure in harsh weather, etc.

**EXCITING CAUSES.** These are grouped under two headings. First, Direct injury to the tissues by mechanical violence, by strong chemicals

or irritants, or by extremes of heat or cold. Second, Infective micro-organisms and their products, these including the numerous pathogenic bacteria already considered in the first chapter. Their mode of action will be further considered when we come to speak of the infective inflammations. It is unquestionably true that many of the ptomaines of saprophytic origin will cause inflammation if injected into the tissues, and some authors define such as a septic inflammation, due to chemical causes; but as it is seldom or practically never met with clinically it is omitted from classification here.

**Changes.**—Let the changes which occur during an acute inflammation be now noted. This can be done by grouping them under three headings. First, Changes in blood vessels and circulation. Second, Exudation of serum and of blood corpuscles. Third, Changes in the inflamed tissues. It is of the utmost importance that we recognize that an inflammation is a process; that the process is the same whether it occur in superficial or deep, or in hard or soft tissues; that the apparent modifications dependent upon histological characteristics are symptomatic only; and last, if not least, the changes which are about to be described do not go on separately but simultaneously, and they are separated for convenience of description.

**CHANGES IN THE BLOOD VESSELS AND CIRCULATION.** We have an irritation of a part, say from mechanical injury; while some observers hold the primary effect to be contraction yet the first constant and noticeable effect is a dilatation of the supplying arteries, when, as a rule, the rapidity of the current is increased. The dilatation increases and extends to the capillaries and veins. After a time the extreme rapidity of the flow is diminished, the retardation being first observed in the veins, then the capillaries, then the arteries. As the stream becomes slower and slower the blood-corpuscles apparently increase in number and the white ones, being forced into the peripheral stream, show a tendency to adhere to the walls of the smaller veins and capillaries, owing, as has already been said, to their light specific gravity. Moving more and more slowly the final adherence to the walls of veins and capillaries is especially notable in the bends of the vessels. They form in layers, affording great obstruction and finally completely occluding the tubes so that all onward movement ceases. The contents sway to and fro for a time with each impulse of the heart, a condition termed oscillation, but in a very short time even this movement ceases and complete stagnation or stasis results. The blood may remain fluid for a few days; but thrombosis results ultimately when the lining membrane of the vessel walls dies. The changes in the vessels themselves are most marked in the capillaries. They consist of softening of the cement substance which binds the nucleated endothelial cells together, and consequent partial separation of these cells. The changes in the small veins are similar, and thus small openings are formed in the vessels, called stomata, through which the vascular contents are extruded.

**ESCAPE OF SERUM, BLOOD AND CORPUSCLES.** While the small veins are becoming lined with the layers of leucocytes the serum of the blood is passing through the vessel walls, and with the further dilatation and partial obstruction the leucocytes nearest to the walls appear to sink into them. They do really sink into the mouths caused by the softening of the intercellular substance, and if the microscope be now used there

may be seen on the outer surface of these vessels little rounded buds or projections.

These elevations increase in size, change from a round to a pear shape, and can finally be recognized from without as white corpuscles attached by a small pedicle to the capillary or vein. When this pedicle gives way the corpuscle is free. This process is termed diapedesis, and begins in the

1

2

**Fig. 4.**

**Areola of Tissue Inflammation.**

1. Fat cells, fat dissolved out.
2. Small vessel surrounded by small, round-celled infiltration.

veins, as has been said, with the slackening of the current. It is most abundant when the onward flow is very slow but ceases with stagnation. In the capillaries, however, it goes on from the beginning, and if it be remembered that the corpuscles are mixed in the capillaries it can be seen that the extent of involvement of these vessels determines largely the proportion of red blood corpuscles in the exudate. Some, no doubt, are exuded in every inflammation, and while they are mostly from the capillaries and are proportionate to the severity of the inflammation, many pass through actual rents in the vessels. The third corpuscle, the so called hematoblast, passes out through the same channels as the red ones, only in proportionately greater quantities, owing to their peripheral location in approaching stasis. In the normal blood these hematoblasts are only one-twentieth as numerous as red ones. They play little part in the process thus far, but no doubt the fibrin formed later is due largely to their disintegration.

There are three factors which assist in the escape of blood-corpuscles; the weakening of the vessel walls from the injury and distension; the pressure from the arterial current; ameboid movements of the white corpuscles. They have now been followed through the walls. What becomes of them?



The red corpuscles and the hematoblasts have no power of locomotion and are carried into the surrounding connective tissue spaces in the escaping serum. This exuded fluid is rich in albumin and some of the elements which contribute to the formation of fibrin. The severer the inflammation the more the fluid resembles blood plasma. The white corpuscles, owing to their movements, find their way not only into the lymph spaces but also into the lymphatic vessels and even into the fixed cells of the inflamed part.

CHANGES IN THE INFLAMED TISSUES. The tissues thus become infiltrated with the serum and blood cells, the parts appearing softened and swollen. As the exudation becomes greater, with the circulation at a stand still, the exudate coagulates and the contracting fibrin squeezes out the fluid portions, which are drained away by the lymphatics. The original tissues of the part, cut off from their blood supply by the injury and the exudate, lose their vitality and either undergo fatty or other degenerative change. This is death from simple mechanical pressure, termed necrobiosis, and may be aseptic. Another way in which the tissues may die is from the local toxic effect of the microbes and their ptomaines. In less intense infective inflammations the fixed tissue cells may, by rapid proliferation, be the means of destroying the invading micro-organisms and thus, while furnishing the bulk of the inflammatory product, limit the extent of the disease.

### CHAPTER III.

## INFLAMMATION CONTINUED.

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Many pathologists still adhere to Virchow's theory that the connective tissue cell proliferation is of primary importance in the production of inflammations. The consensus of opinion, however, seems to be with Conheim, that if injury to any one tissue is capable of exciting inflammation that tissue is the vessel wall. Certainly, in acute inflammations all of the early symptoms are vascular; still there is little reason to doubt that both elements play important parts, and the more acute the inflammation the greater the part we can claim for the vascular element, while the more chronic the inflammation the greater the part for the fixed cells.

The change productive of inflammation, whatever its nature, may be brought about in ways corresponding to the exciting causes which are above mentioned: From direct injury to the vessel walls, or indirect through the adjacent structures, or from the influence of the micro-organisms and their ptomaines.

There are two kinds of inflammation, acute and chronic, and two varieties of each kind, simple and infective.

**Simple Inflammation.**—Inflammation is classed as simple or plastic when the parts are in an aseptic condition. The cause is always direct injury. Its special characteristic is its limitation, showing no tendency to spread beyond the injured area and usually subsiding when the cause ceases to act.

The cause and the changes may be stated briefly thus: Dilatation of the vessels and increased rapidity of the circulation; still further dilatation with a marked slowing of the blood current; gathering of the leucocytes in layers about the vessel walls; partial separation of the endothelial plates through softening of the albuminous cement substance, thus forming stomata into which the ameboid cells penetrate and pass; following and gathering together of the other globules with the serum into the perivascular tissues; still further slowing of circulation on account of mechanical obstruction until complete stasis obtains; coagulation of exudate; contraction of newly found fibrin, which squeezes out the liquid portion of exudate and leaves numerous cells enmeshed in bundles of contracting fibrin.

One important fact must be remembered—that in this weakened condition the tissues are not able to resist the entrance and development of micro-organisms should they reach that locality, either by direct contact or through the circulation. Thus what at first may have been a simple inflammation becomes transformed into an infective one. Simple inflammations are termed serous, fibrinous or hemorrhagic, according to the duration, intensity, and character of the exudate.

**RESOLUTION.** The fate of this exudate differs; the fluid portions, as has been seen, are usually at once absorbed by the lymphatics and the cellular portion may thus be taken up; but as a rule it undergoes fatty

degeneration and absorption, though it may, and often does, become organized after the inflammation has subsided, giving us the so called productive inflammation.

**Infective Inflammation.**—The forms of this variety, in which we are especially interested, are the phlegmonous or suppurative, the erysipelatous and the tubercular. They differ from the simple inflammations in that they are caused by definite or specific micro-organisms. The changes they produce do not differ from the process as described, save in the tendency to spread and the almost certain destruction of more or less of the involved tissues.

Let us now see in what ways inflammation may spread. An inflammation never spreads except its cause spreads before it; this is equivalent to saying that all spreading inflammations are of the infective variety. They spread in one of three ways: By continuity of tissue, by the lymphatic channels, and by the blood vessels. It need not be explained how, the reason being obvious.

**SYMPTOMS.** The symptoms by which acute inflammation may be recognized are five—redness, heat, pain, swelling, impaired function.

*Redness.* The redness is due to the increased blood supply and is proportionate to the intensity; capillaries formerly too small to be seen become enormously dilated. Redness is most marked in the stages before stasis while the vessels are widely dilated and the circulation active. After exudation begins it is apt to become mottled from escape of red blood corpuscles, even growing bluish if suppuration follows.

*Heat.* There is no generation of heat in the part itself, as that requires increased nutritive changes for its production. The local temperature never exceeds that of the circulating blood. In every developed inflammation, no matter how large or how small, there are three distinct zones of tissues; the central, where stasis is complete; the next where circulation is going on but slowly, and the external zone of active hyperemia. It is to this last zone that the redness is due. The increase is due to the rapidity of circulation and the amount of blood in the part. In those cases where the circulation is completely occluded the symptom disappears. It is interesting to note the absence of heat as well as redness in the central area, and that it is only manifest in the outlying zone of active hyperemia.

*Swelling.* The dilatation of the vessels may cause a slight enlargement, but the swelling is mostly due to the exudation of serum and leucocytes, and later, in part, to the proliferation from the fixed tissue cells. The more acute the inflammation the more is the swelling due to the escaped leucocytes. The more chronic, the greater the cell proliferation.

*Pain.* This is due to pressure upon nerve endings by the dilated vessels and by the exudate; possibly at times, too, by the involvement of the nerves in the inflammatory process. It varies in character and intensity in the different structures, and is increased by pressure and the dependent position. The proof that it is due to tension is the relief that immediately follows free incision.

*Impaired Function.* This is due in part to the injury and in part to pressure and consequent malnutrition, and differs in its manifestations according to the structures involved.



**Treatment of Acute Inflammation.**—The importance of recognizing the cause of inflammation is not only essential to proper treatment but also to a just prognosis. The prognosis of simple inflammation is nearly always good, providing the case be taken in charge in time to prevent secondary infection. That of infective inflammation depends upon the virulence of the microbe causing the trouble, upon the anatomical arrangement, and the physiological importance of the invaded part, and also upon the general resisting power of the patient and the accessibility of the lesion to surgical treatment. The treatment may be divided into preventive and curative and, as in all diseases, prophylaxis is the more gratifying.

**PROPHYLAXIS.** There is a great deal of satisfaction in preventing inflammations in persons prone to them by an effort to increase the general health; that is, by removing the predisposing causes. Placed in the best possible hygienic conditions, with plenty of food, plenty of out door air, with moderate exercise, above all plenty of pure water, both internally and externally and they will have been given the best and most complete barrier against any disease. It is the acme of satisfaction, however, to have accidental wounds and operations heal without inflammation, and this can be almost a surety if the details of antiseptic surgery are carried out. This is the one fact which modern surgical methods have so strongly upheld that makes the surgeon more than ever incline to the belief that all inflammations are in reality of microbic origin. By this is meant, of course, all of those cases which are met with clinically, for as yet nobody can deny that what is termed inflammation may result from traumatism and irritants. And still, if simple traumatism is sufficient to cause this disturbance why can such extensive operations be performed under aseptic methods without inflammatory reaction? This problem is still waiting satisfactory solution.

**CURATIVE TREATMENT.** In the early stages of inflammation anything which tends to diminish the amount of blood sent to the part will lessen the activity or rather the intensity of the process. With a view to this end among the most important measures are:

First, *Rest and Position.* Elevate the part; remove all constriction of the returning blood current, carefully maintaining perfect rest, not only of the inflamed part, but the whole body; movements always hasten circulation and will aggravate the local trouble.

Second, *Cold.* Cold applications, especially if taken in connection with elevation and rest, are among our surest safeguards against an excessive inflammation. To be of any service, the application must be continuous and used only in the early stages. If so used it prevents the extreme distension of veins and capillaries which is necessary to extensive exudations, and exerts at least an inhibitory effect upon the micro-organisms. Cold should be applied in the form of icebags, the continuous coil, or, when moisture is also required, by complete immersion, or by protecting the rest of the body with a rubber sheet and allowing a continuous irrigation from a vessel above. Irregularity in its application encourages inflammatory process by damaging the tissues. Cold is, of course, most effective in superficial inflammations, but should never be used after stasis is complete.

Third, *Compression.* If cold is not well borne compression is the

next assistant. Indeed, they may be combined, the cold being applied after smooth and even compression has been made by a flannel bandage.

Among the causes of this exudation of blood corpuscles were a weakened condition of the vessels and arterial pressure. Clinically it is found that compression of the main artery will control the diapedesis. It seems rational, then, that to lessen this arterial pressure in the inflamed tissues and support the weakened veins by a semi-elastic bandage would be beneficial in the early stages of acute, and also in chronic, inflammations. In the height of an acute inflammation compression should never be used for fear of crushing out what little life the tissues still preserve. Other methods of using this agent are by means of the rubber bandage, elastic wool, or by the graduated compress and ordinary bandage.

Compression is also especially valuable in limiting superficial spreading inflammation, such as erysipelas.

Fourth, *Heat*. When elevation, rest, cold and compression have been tried and have failed, or when the patient appeals to us first with the inflamed area in a state of complete stasis, heat, either dry or moist, by acting as a local stimulant, may cause a return of the normal circulation, and, later, hasten the absorption of the exudate. Hot antiseptic fomentations are as a rule very soothing, relieving much of the pain, and having a tendency to abort a threatened suppuration. They also hasten that process when already begun. The solutions used may be of any of the reliable antiseptics, acetate of aluminum one per cent., boracic acid, saturated solution, carbolic acid 1-100 or 1-500, bichloride of mercury 1-1000 to 1-5000; the strength depending upon the extent of involvement. A good method of applying heat is to saturate flannel with a hot antiseptic solution, lay it smoothly over the part, cover with a large piece of oil-silk and then keep hot by the continuous rubber coil or the hot water bags. Poultices, though really things of the past, may be useful at times. When used and the wound is open they should be rendered antiseptic by the addition of a reliable germicide.

Fifth, *Incision*. When the inflammation is very angry, when it shows a tendency to spread over a large surface, and where suppuration threatens, early incision is a duty. It is not best to wait until suppuration has formed, for incision brings an almost immediate relief from pain; it relieves the tissues of destructive tension and enables the direct application of antiseptic lotions. These latter should always follow incision of an inflamed area, either as hot fomentations or as a moist antiseptic dressing.

Sixth, *Parenchymatous Injections*. These have not proven so markedly beneficial as they gave promise of doing. The injections are of antiseptic solutions, the object being to destroy the micro-organisms in the tissues, or at least to inhibit their development and give the tissues opportunity to overcome them. Successes and failures have attended the use of permanganate of potash, nitrate of silver, bichloride of mercury, carbolic acid, iodine and iodoform. Carbolic acid has thus far proved the most satisfactory in general inflammation, but on account of the dangers of poisoning, if used in quantities sufficient to have much effect in large foci of inflammation, its use should be limited to circumscribed inflammations such as furuncles, carbuncles, encysted serous effusions, chronic bursitis and lymphadenitis. It may be used in strengths ranging from three per cent.

to five per cent. solution or even the ninety-five per cent. c. p. may be used in small quantities. Carbolic acid is useful in full strength and is not absorbed as readily as in solution, because it destroys and mummifies a layer of tissue through which absorption no longer occurs. Iodoform in a ten per cent. emulsion with glycerine has perhaps the best record thus far in chronic inflammations of tubercular origin. From the percentage of cures effected by its employment it must be recognized as a valuable remedy. Formerly it was used in an ether solution, but the glycerine is better as it soon deposits the iodoform in the tissues, itself becoming absorbed, while being soluble in ether the iodoform is absorbed and may produce poisonous symptoms.

**Chronic Inflammation.**—The pathological conditions are much the same as in the acute form, the differences being mainly the longer time of its development and the greater tendency to produce a chronic thickening of the tissues, which later shows the leading toward calcareous or caseous degeneration. The explanation of this lies in the fact that the fixed cell elements predominate over the leucocytes in the production of the inflammatory swelling. Under the heading of chronic inflammation may be placed the infective granulomata such as tubercles, syphilitic nodes, glanders, and the like. More will be said of them later.

**CAUSES.** These are the same as the acute, only they must of necessity act less violently and for a longer time. The constitutional conditions most active as predisponents are lithemic conditions, gout, tuberculosis, rheumatism and syphilis.

**SYMPTOMS.** While neither so marked nor so severe they are of about the same kind as in acute. The redness and heat may be entirely absent, pain and especially tenderness, swelling and deranged function being the most reliable symptoms. The swelling is, of course, more firm than in the acute and may, by organization of the tissue-cells, become permanent.

**TREATMENT.** The treatment may be summed up in three dictums. Remove the cause. Promote absorption of organized exudate. Establish healthy circulation.

For removal of the causes both local and constitutional measures may be needed. General treatment is of the utmost importance, especially if the history of the case show either tubercular, syphilitic or rheumatic taint. Local treatment is like to that of acute variety; rest, position, pressure, operation. To these add massage, which is exceedingly important here. Properly applied it stimulates both the circulation and absorption and thus brings about a condition approaching the normal. Electricity acts in the same way. The galvanic current of a mild form should be chosen, the treatment not to be used too long and not oftener than once a day or once in two days. If a chronic inflammation become the seat of a secondary infection and develop acute symptoms it should be treated as an acute case.



## CHAPTER IV.

### SUPPURATIVE INFLAMMATION.

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**Primary Considerations.**—Of the infective inflammations the most important, because the most common, is suppuration. The chapter on suppurative inflammation will be based upon the three essential factors in its causation. First, micro-organisms in sufficient numbers. Second, tissues of lessened resisting power than normal. Third, the arrest of the micro-organisms in such tissues for a sufficient length of time.

In the light of recent investigation and experiment these are truths. Is suppuration ever produced without micro-organisms? Experimentally, in the laboratory, yes. Clinically, in actual surgical practice, never. It is a fact of scientific interest only that the changes in tissue destruction which are termed suppuration may be induced experimentally by the hypodermatic injection of sterilized ptomaines and leucomaines, filtered and sterilized pus cultures, and also of certain chemicals, croton oil, turpentine, nitrate of silver, etc. This fact is due to the power of exciting inflammation and at the same time preventing the formation of fibrin. The inflammation is strictly limited to the tissues brought into direct contact with the chemical agent, and, hence, is non-infective, lacking the one essential element of reproduction, a living germ. The discussions of such questions must be left to bacteriologists. The important facts for the surgeon to recognize are that suppuration is a destructive disease; that it is due to an omnipresent living power which will multiply and extend its baneful influences, and that to prevent it the most stringent rules of surgical cleanliness must necessarily be followed.

It does not seem necessary to describe or even to mention the many varieties of germs that recent research has determined will cause suppurative inflammations. They are termed, collectively, the pus microbes. Those most commonly at fault, the staphylococcus albus and aureus and the streptococcus pyogenes, have already been briefly described in the chapter on surgical bacteriology. Their entrance into the system is invariably through an abraded skin or through some mucous membrane. The fact that they can be rubbed into an unbroken skin and produce inflammation has no clinical significance. That even these most virulent forms must be introduced in considerable numbers to produce their pathogenic effects is proven beyond question by experimental inoculations, both in animals and in man. Small numbers are either at once destroyed by the blood plasma or by the fixed tissue cells (phagocytosis) before they have time to produce their pathological effects, their utmost being to cause a very mild and circumscribed inflammation that terminates in resolution. It is interesting to note the experiments of Watson Cheyne with pure cultures of the golden-grape coccus. He estimates that 250,000,000 of these cocci are necessary to produce a small abscess in a healthy rabbit, while the injection of 1,000,000,000

produced a rapidly fatal result from progressive septicemia before suppuration had time to occur.

The second essential causative factor of suppuration, i. e., tissues of diminished resistance, is scarcely less important than the first. This condition may be brought about by injury or by previous disease. The ways in which traumatism may act as a localizing factor have already been discussed. Indeed, enthusiastic supporters of the microbial cause of suppuration claim that chemical matters which appear to provoke suppuration in reality simply place the tissues in a condition to determine the localization of floating microbes. The important part the condition of the tissues plays is proven by the fact that inoculations which are ineffectual without give rise to typical suppurating foci when preceded by traumatism of the parts inoculated. It is best exemplified clinically in the fact that the same micro-organisms which may cause a simple furuncle in one person might cause a carbuncle in a second or a case of rapidly progressive septicemia in a third.

The third proposition, the necessity of time, every surgeon of experience must recognize clinically. No matter how weak or how poor a fight the tissues are capable of making it will take a certain time for the invading microbes to produce suppurative changes. Most experimenters agree with Renne that where the so termed "absorptive capacity" of the tissues is not diminished the pus microbes are removed too rapidly to exert their destructive influence. This is positively proven by the facts that pus microbes have often been discovered in acute inflammations treated by incision prior to pus formation, and that inoculations of large quantities of the germs may produce death in from eighteen to forty-eight hours without any evidence of suppuration in the inflamed parts. The development and progress after the micro-organisms gain entrance depend not only upon the anatomical arrangement of the parts but also upon the method of infection and the specific microbe. This will be appreciated more clearly when the ways in which extension takes place are recalled, i. e., by continuity of structure by means of the blood-vessels and through the lymphatics. Any microbe productive of suppurative inflammation may spread by means of the blood-current, either by gaining direct entrance or by causing an infective thrombus which undergoes secondary softening and is distributed throughout the system. One of the greatest distinctions between the staphylococcus and streptococcus is that the former, spreading by continuity of structure, tends to produce suppurations which are circumscribed, while the latter, spreading by the lymphatics, produces diffused suppurations. The arrest is most frequently at the point of inoculation, especially if that be an abrasion of the skin, but the possibility of the localization of circulating micro-organisms either by traumatism, by chilling of the tissues, or in parts the seat of previous diseased conditions, must always be borne in mind.

Suppurative inflammations may be circumscribed or diffused. Circumscribed suppurations occurring beneath the surface are known as abscesses.

**Acute Abscesses.**—The microbes, most commonly the yellow grape coccus, becoming arrested in suitable soil, begin to multiply, abstracting nourishment from the tissues and throwing off the products

of the tissue metabolism. They cause first an active hyperemia, the affected area being red and hotter than the para-tissues. The circulation becomes slower, exudation takes place and the microbes penetrate the exudate and tissues in all directions. At every point they are met by large quantities of exuded white corpuscles. The exudation grows very dense, filling up all the lymph spaces. Partly owing to the obstructed circulation and partly to the direct action of the microbes and their toxins, which liquefy the fibrin, the central portion of the inflamed area begins to soften and break down.

The battle of the leucocytes and connective tissue cells against the advancing microbes is still going on a short distance from the softened center and still external to this is the active hyperemia. As the disease extends these zones spread wider and wider, but in every abscess that is fully formed there are three distinct zones; from without inward, a zone of active hyperemia and connective tissue reproduction; an inflammatory zone, stage of exudation; and a central zone of beginning pus formation. (Fig. 5.) By degrees the virulence of the micro-organisms becomes ex-

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**Fig. 5.**  
**Commencing Areolar Abscess.**

1. Focus of leucocytes.
2. The edematous areolar tissue.

hausted and at last the layers of round cells produced in the zone of hyperemia are sufficiently thick to prevent their further invasion. Thus the spreading is checked, but rarely for a long time, the microbes retaining still enough energy to invade the wall at places.

As the point of least resistance is usually toward the surface the swelling assumes a conical form and the skin becomes very tense and shiny. The abscess is now said to be "pointing," and fluctuation is easily detected. As the walls become too much attenuated to withstand the



increased pressure they rupture and the abscess is evacuated. As soon as the spreading ceases the infiltrated tissues begin to react, the round cell proliferation in the zone of hyperemia becomes traversed by minute blood vessels of new formation, and are thus converted into a layer of granulation tissue around the central cavity. It is the attack upon these granulations by the microbes, and the degeneration of the superficial layers under their action, that made the old authors refer to this as a pyogenic or pus-forming membrane. Its function is, in reality, pyophylactic rather than pyogenic.

Suppuration is, then, the molecular death of the inflammatory exudate and of the inflamed tissues. The product of this destruction is termed pus and consists of leucocytes and connective cells, the vitality of which has been destroyed by the microbes and their chemical toxins, and of fat globules. (Fig. 6.) All of these are suspended in the serous exu-

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**Fig. 6.**

**Pus.**

1. Chain of streptococci.
2. A pus cell with quadro-partite nucleus.
3. Scattered streptococci.

date, plus the liquefied fibrin. It holds in solution the chemical products of the disintegration and some microbes, both living and dead. Such names as sanious, ichorous, curdy, bony, are frequently met with as descriptive of the character of the pus, the names explaining themselves. The term "laudable pus" was long used by surgeons to denote what seemed to them to be a satisfactory condition of pus. No pus is "laudable," if by the term it is meant to imply that its presence indicates a healthy state of wound.

**DIAGNOSIS.** The diagnosis of acute abscess as a rule presents no serious difficulty. The symptoms are those of acute inflammation. The pain is usually intense in the early stages and of a sharp, tearing nature

owing to the extreme tension upon the delicate nerve filaments. Though pus may form without the slightest manifestation of chill, as a rule its formation is denoted by rigors or a chill and a change in the character of the pain from a sharp lancinating pain to one of a dull throbbing nature. The swelling, at first hard and indefinite, becomes circumscribed, assumes a conical shape and softens in the center. With establishment of fluctuation there is marked abatement of all symptoms. An abscess over a large artery may simulate aneurism, but the pulsation will be heaving and not expansile; the size of the tumor cannot be lessened by steady pressure; the dependent posture will not increase the size, and if the artery be compressed on the proximal side pulsation stops, of course, but is resumed with original volume immediately it is relieved. All these symptoms are contrary in aneurism, but when in doubt aspiration with a very fine needle may be practiced to decide.

**TREATMENT.** In the general treatment of abscess, only those fully developed shall be treated of, the dangers of suppuration and the importance of aborting the inflammation before disintegration begins having already been described. The treatment by early incision cannot be too strongly urged; the reasons for it are, the immediate relief from pain; the relief to the tissues of destructive tension; the enabling of direct application of antiseptics. Prevention above cure, always. The cardinal features in the treatment of acute abscesses are:

First, Thorough evacuation of the contents with as little injury as possible to surrounding tissues. Second, The supplying of perfect drainage. Third, Rendering the cavity aseptic. Fourth, Prevention of further infection by means of antiseptic absorbent dressings. If only one of these objects can be attained the most important of the four is perfect drainage. With that assured nature can do the rest.

Of the three recognized methods of accomplishing these ends the first and most satisfactory is by incision. An anesthetic is indispensable to the thorough treatment of abscesses. The practice of making a small opening and squeezing out the pus is as nonsensical as it is painful. Frequent irrigation is no substitute for perfect drainage. The first incision should be made in the direction of the longitudinal fibres in the line of most distinct fluctuation, and it should be made large enough. The index finger, which is always the best probe, should be introduced, not for the sake of roughly breaking down the softened tissues but to explore every recess and to determine whether or not the curette should be used, and also the best location for drainage tubes. Having determined the extent of the disease counter incisions at the extreme limits and plenty of them may be necessary to insure perfect drainage. Thorough irrigation with an antiseptic solution should next be done, all the softened tissues being gently removed with the assistance of the finger and curette. Drainage tubes are next in order, not forgetting safety pins, and the cavity should be filled with peroxide of hydrogen to destroy the last vestige of pus corpuscle. If the opening is large it should be in part sutured with silk-worm not too tightly tied. A final douching with an antiseptic lotion and an application of an ample antiseptic moist dressing, tolerably firm compression being used.

*Hilton's Method.* This is especially valuable in deep seated abscesses or when located among important structures. It consists in a primary

incision extending through the skin and superficial fascia, and the separation of deep tissues with a grooved director until the abscess cavity is reached. As soon as the pus escapes a pair of closed dressing forceps is passed along the director into the cavity. This is withdrawn with the blades separated sufficiently widely to make an opening large enough to admit a good sized drainage tube. Irrigation and dressing as before is practiced. In these deep abscesses gentle pressure is sometimes necessary to thoroughly empty the cavity, but in the superficial ones where the parts are badly inflamed it is highly injurious, sloughing of the bruised parts frequently following.

*Aspiration.* This method is not so frequently resorted to as formerly. It is of occasional value for collections of pus in the natural cavities of the body and especially in the treatment of chronic abscesses. The part where the puncture is to be made being thoroughly cleansed and the needle of the aspirator being disinfected, either by boiling or by heating in an alcohol flame, the contents are evacuated, thorough irrigation with a mild antiseptic solution follows, and a final injection into the cavity of some of the preparations already recommended, iodoform emulsion, solution of iodine or carbolic acid, etc., is practical.

**Chronic Circumscribed Suppuration.**—Chronic abscesses are as a rule tubercular abscesses, and arise most frequently in connection with tuberculosis of bone and glands. They may be the result of secondary infection with pus microbes of a granulating tubercular or syphilitic focus, the original disease having spent itself. The irritant action of these microbial colonies is of very slight intensity, the former inflammatory trouble has developed so firm a limiting membrane of granulation tissue that the destruction of the wall into pus cells is very slow and the abscess may remain undiscovered for a long time. These forms will be described either in dealing with special abscesses or in considering tubercular inflammations, and are simply mentioned here in order to impress the fact that while the indications for surgical interference are not so urgent as in the acute varieties the necessity for the strictest and most thorough antiseptic work is even more imperative. The tissues are so feebly resistant that if secondary suppuration results from carelessness in the operation the infection is wide-spread and the patient is in great danger of septicemia. Unless perfectly assured of every precaution having been taken by far the safer plan is antiseptic aspiration and injection; but if the surgeon is confident of his surroundings and assistants, and above all of himself, the free opening and thorough curetting of the diseased tissue under antiseptic irrigation, the drying of the cavity with iodoform gauze, the dusting with iodoform and the supplying of free drainage furnish the proper course. When he can see that all diseased tissue is removed, after looking into every recess, he should suture as in any operative wound. When not thus assured, the cavity is packed with iodoform gauze, the sutures being introduced but not tied. When granulation becomes healthy and natural the sutures can be tightened and union by secondary adhesion secured.

**DIFFUSE SUPPURATION**, or, as it was formerly termed, phlegmonous erysipelas, as has already been said, is most frequently caused by infection with the streptococcus pyogenes, though it may be mixed with either form of the grape-coccus. This streptococcus cannot be satisfactorily



distinguished from the streptococcus of erysipelas. In appearance and in culture they are apparently the same, but in the tissues the pyogenic coccus is found not only in lymph spaces but passes along the connective tissue as well and penetrates the vessel walls, the affection of the skin being a secondary instead of a primary one. The great tendency is to rapid spreading in the line of least resistance, such as the connective tissue spaces, muscular sheaths and tendon sheaths. In the study of diffuse suppurations the necessity of understanding the fascia and its arrangement in different parts of the body cannot be overestimated. This is a part of the anatomy only secondary in importance to the surgeon to the vascular and nerve supply. It is indeed difficult to treat deep accumulations of pus satisfactorily unless an idea can be formed as to where the original focus is located; for sometimes these burroughing abscesses, as they were formerly called, "point" at a great distance from the real seat of the disease.

The pathological changes need not be repeated; they differ from those described in abscess formation simply in extent, nature being unable to form the limiting cell wall. The widespread action of the micro-organisms makes it easy to understand why the constitutional symptoms are so severe. They are most commonly due to septic intoxication which will be described later.

**TREATMENT.** Free incisions under antiseptic irrigation are to be made wherever the tension is sufficient to place the tissues in danger; drainage tubes are to be introduced and the best possible position for perfect drainage is assumed. If the inflammation is so extreme that the vitality is low and danger of sloughing imminent no immediate effort should be made to dress the part, but application of some hot antiseptic solution or complete submersion should be practiced until the tissues show evidence of regaining their vitality; then the moist dressing, and, in abscesses in the extremities, elevation and continuous irrigation may be substituted. If such cases run neglected the disease extends and general infection results. Veins and lymphatics come under the influence of the microbes, septic thrombi result, and, becoming detached, are carried into the circulation and located in different organs, thus forming new foci and secondary abscesses. The general symptoms become correspondingly severe and a typical case of pyemia presents; a disease almost incurable. In most cases this serious accident can be prevented by proper and energetic treatment applied early.

In such operations an Esmarch's constrictor may be necessary, not only to save the blood but to prevent absorption of the antiseptic used, which, to be of value in so extensive an involvement, must be strong and continuous during the operation.

The prognosis depends upon the extent of the disease and the time at which the patient applies for treatment, or, in other words, the extent of tissue destruction and the severity of the constitutional symptoms.

## CHAPTER V. SPECIAL ABSCESSSES.

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**Genera.**—Among the special forms of suppuration which are regarded as little things and which, if neglected, may result seriously, is the so called felon or whitlow, a suppurative inflammation involving the fingers. There are two kinds, styled the superficial and the deep. The superficial is really an inflammation of the sheath of the tendon and should be named tendo-vaginitis. The deep is a circumscribed osteo-periostitis. They are usually the effect of direct infection through a puncture or the prick of a sharp instrument, but may arise from a bruise, circulating microbes being arrested by the simple inflammation thus excited.

**Symptoms.**—Owing to the dense and twisted fibres on the palmer surface of the finger and hand the pain is out of all proportion to the apparent extent of the disease; it is of an intense throbbing nature and greatly aggravated by placing the hand in a dependent position. The swelling is moderate but the tension is very great. It actually seems that the finger will burst open. In the superficial form the chief danger, and it cannot be overestimated, is extension of the disease along the sheath, involving the common sheath for the flexor tendons in the palm. This is especially liable if the thumb or little finger is the seat of the disease, for these two sheaths connect directly with the general palmer bursa while those of the other fingers are separated. In the deeper variety the danger, in neglected cases, is involvement of the shaft of the bone and necrosis. This danger should be explained to the patient and insistence upon implicit obedience of orders be enjoined.

**Treatment.**—Ice water is said to lessen the blood supply, inhibit microbial growth, and many times it prevents development. As a rule patients apply too late for such suggestions. The use of a 1-500 bichloride of mercury in absorbent cotton compresses kept constantly hot and moist will in many cases prevent suppuration. When the acuteness of the symptoms has subsided one of the compresses should be placed over the part and the solution be kept from evaporating by wrapping with a piece of gutta-percha tissue. When the disease progresses in spite of these precautions, or if the surgeon be called too late for their employment, free incision down to the suppurating focus is the only treatment to adopt. The antiseptic fomentations will follow with the proper results if the drainage is free. When tension is very great, even if no pus is found, the incision is the proper line of treatment, because of its almost immediate relief of pain and of the dangerous tension.

In the early stages of the periostitic form if the surgeon is able, by the use of a probe, to determine the spot of most acute tenderness he should thrust a tenatome through it clear to the bone. This slight puncture if correctly made is sufficient. Nine chances out of ten the knife will have to be resorted to soon or late. If dilatory measures of hot applications be indulged in until extreme suffering forces submission

to anything for relief the incision will have to be much larger, possibly multiple, and the recovery will be more lingering and the relief less marked. The parts are extremely painful and tender, but may be readily incised without pain by using a spray of ethyl chloride.

If the patient does not apply for treatment until the whole hand is involved in suppuration it should be treated on general principles of diffused suppuration. Free incisions, avoiding as far as possible the palmar arches, the careful emptying of every recess, and, if the parts are badly disintegrated, vertical suspension with constant irrigation or continued immersion in a weak antiseptic solution at a temperature to suit the patient is the treatment. In ordinary cases the application of a moist antiseptic dressing will suffice.

**Furuncle.**—Furuncles, or boils, are circumscribed phlegmonous inflammations developed about a sebaceous gland or a hair follicle; in short, small abscesses. They are especially interesting not only for their frequency but because the process is usually so rapid that the connective tissue fibres have too little time to become liquefied fully and are extruded as a dead, hard mass vulgarly referred to as a “core.” Defective glandular action resulting in retained discharges and accumulation of “dirt,” which is no doubt full of microbial colonies, are the acknowledged causes. The microbe most frequently found is the staphylococcus albus either alone or combined. That boils are especially prevalent in people subject to renal and hepatic diseases is due, first, to the fact that the small glands excrete products irritating to them, and second, to the interference in general nutrition by reason of faulty glandular action and the retention of poisonous matters in the blood. The symptoms and course of the disease are too familiar to demand description.

**TREATMENT.** If the patient is seen in the very beginning, the removal of retained secretions and the injection with a hypodermic syringe of a drop or two of pure carbolic acid will stop them. After the injection, before which the part should be cleanly shaved, it should be painted with iodoformized or mercuric collodion. When fully developed, free incision, irrigation and moist antiseptic dressing is the treatment.

**Carbuncle.**—One of the most severe forms of superficial phlegmon is the carbuncle, which is described as “a specific spreading inflammation of the subcutaneous structures, involving also the skin and terminating in gangrene of the affected tissue, which is discharged in the form of sloughs.” The most frequent locations of this disease are the nape of the neck and the back. It may occur, however, in any locality. Those of the face are especially dangerous, from the occurrence of suppurative phlebitis and the tendency of septic thrombi passing through the angular and ophthalmic veins to the sinuses of the skull. The cause is the same as of other phlegmon, the gangrenous tendency indicating the streptococcus pyogenes.

**SYMPTOMS.** Carbuncle begins as a hard, painful swelling, accompanied by fever and marked depression. The inflammation spreads rapidly and soon appears as a flattened, circular elevation, the surrounding skin becoming markedly indurated and red. As the process extends the constitutional symptoms become alarming; high fever, headache and frequently delirium. The redness changes to bluish or purplish color, small vesicles form on the surface and on bursting expose yellowish sloughs through the



numerous apertures, the induration subsiding partly, the tissues becoming spongy in texture. These apertures coalesce as the process extends, the whole of the infected area sloughing away. If, now, the inflammation subsides the wound becomes one of healthy granulations which causes the expulsion of the sloughing tissue; but if it continues the general symptoms assume a typhoid character, the vitality becoming so lowered at times as to cause symptoms of collapse with subnormal temperature, the patient dying from exhaustion or blood-poisoning.

**DIAGNOSIS.** The diagnosis presents little difficulty. Carbuncle is termed by some authors a group of furuncles, but differs clinically from a furuncle in the following particulars: It is larger, shows greater tendency to spread, is flattened rather than conical in shape; the surrounding induration is more marked, it ruptures in many places, not simply at the apex, the destroyed tissue comes away in sloughs, not as a single "core," and the constitutional symptoms are of much more severe type.

**TREATMENT.** From the tendency to rapid destruction early and energetic treatment is demanded. Anesthesia is indispensable in the surgical treatment of these cases. Before the infectious nature of carbuncle was understood and while antiseptic surgery was in its infancy the expectant plan of treatment gave better results than the operative. Sir J. Paget voiced the sentiment of his confreres in stating that, "Incision was dangerous and unsatisfactory." Even now that opinion prevails among the majority of physicians, and the surgeon may be compelled in many cases to adopt those expectant methods which will be described later. As Paget voiced the sentiments of a few years ago Gerster voices those of modern surgeons, thus: "Formerly topical applications were the main reliance, incision the last resort. The surgeon was obliged to show why an incision should be made. At present, relief of the tension and escape of noxious substances through incision and drainage are the clear indications. The surgeon must show cause why an incision should not be made."

If carried out with due regard to cleanliness the plan of early incision will bring the results claimed for it, viz.: Relief of pain, limitation of the spreading, hastening of the sloughing process and cure. The patient being prepared as for any operation a sufficient number of longitudinal incisions should be made through the diseased tissue to enable the complete removal with a curette and forceps of all loose sloughs and decomposed tissues. This should be carried out under constant irrigation with a reliable antiseptic solution. Every recess should be dusted carefully with iodoform and union prevented by means of strips of gauze placed loosely in the incisions. Moist dressings are applied and should be changed frequently, never allowing them to become much soiled with discharges. As the wound heals it is dressed permanently.

In bad cases, where the sloughing and decomposition are marked, continuous irrigation with a mild bichloride or acetate of aluminum or boracic acid solution is in order. Hot antiseptic fomentations are better than the moist dressing.

The actual cautery is highly recommended when the patient is very anemic and the loss of blood in incision would seriously retard his recovery. The advice is to burn thoroughly, converting the whole area into

a dry eschar. If surrounding infiltration is extreme, Volkman's multiple puncture will relieve the danger of necrosis. This consists of a great many punctures with the end of a scalpel, and relieves the tension markedly by giving vent to a free discharge of blood and serum. The so-termed expectant plan consists in topical applications combined with internal medication. Of all local applications a 1-2000 solution of bichloride of mercury in calendula is the best. The application should be hot and kept so until satisfied either that it will or will not act favorably. The orifices should be syringed out frequently either with this solution or with peroxide of hydrogen.

**Glandular Abscesses.**—The treatment of phlegmonous inflammation of the glands does not differ materially from that of a similar process elsewhere, but inflamed lymphatic structures are interesting in many particulars, among which may be mentioned the relation they bear to important blood-vessels; their intimate connection with each other; the fact that it is through them many poisonous matters are disseminated through the system; that they are thus so liable to secondary invasion; and, last, that being located in connective tissue planes they are so frequently the cause of diffused suppuration.

**Cervical Abscesses.**—The cervical glands will first be considered. The superficial ones do not need special consideration. They should be treated on the same general principles as the deep ones. The deep ones may be roughly divided into two groups, the upper and the lower; the former being along the carotid artery and internal jugular vein, the latter along the subclavian vessels. It is of the utmost importance to recognize the arrangement of the cervical fascia and the connective tissue planes of the neck. The most interesting in connection with glandular phlegmon is the perivascular interspace, which is the connective tissue plane surrounding the carotid vessels and in which are located the most of the upper set of deep cervical lymphatic glands. It connects below with the anterior mediastinum. In the latter, which is contained in the triangular space bounded by the clavicle, trapezius and sterno-mastoid muscles, are located the greatest number of the lower glands. Following the subclavian vessels this plane connects below with the axilla. There are two other connective tissue planes, one of which attaches the pharynx esophagus to the spine, termed the retro-visceral, which is prolonged into the posterior mediastinum and is of especial interest in connection with retro-pharyngeal abscesses, and the pre-visceral, which separates the infra-hyoid group of muscles from the larynx and trachea and is continuous below with the anterior mediastinum. With these points before us we cannot fail to appreciate the dangers of dilatory measures when these glands are involved in acute phlegmonous inflammation, and to those patients who prefer the poulticing process the danger should be explained and the responsibility placed upon their own shoulders. These abscesses are usually secondary to suppurative inflammation about the head, mouth or nose. When suppuration is inevitable, the general symptoms progressive, and the tendency to spread marked, total excision before the capsule is ruptured is the ideal treatment. With peri-glandular involvement the tension should be relieved at once by incision. When the attack is less violent the trouble may be aborted by the thorough cleansing of the original point of invasion, be that the oral or nasal cavity

or pharynx, with local application suitable to the stage of inflammation. When rupture of the gland has involved the connective tissue in a diffuse suppuration multiple and adequate incision and free drainage are imperative.

**Axillary Abscesses.**—These glands are arranged in three groups; one along the long thoracic artery, to which the superficial lymphatics of the mammary and upper abdominal regions are tributary; one along the subscapular vessels, which receive the lymphatics from the upper and posterior thoracic regions, and one along the axillary vessels proper, receiving the lymphatics from the hand and arm. The treatment is the same as for cervical abscesses. In diffuse suppuration of the axilla the incision should be longitudinal and midway between the anterior and posterior axillary folds on the thoracic side. In this way the three important arteries of this region, the axillary, the long thoracic and the subscapular are avoided.

**Mammary Abscesses.**—The infection may be through a fissured nipple, there may be no abrasion whatever, or, and in all probability, infection takes place through the milk ducts. There are three kinds of abscesses in connection with the mammary glands; the supra-mammary, the intra-mammary and the sub-mammary.

The treatment of non-suppurative inflammation should be conducted on general principles, simply remembering that secretions must not be retained. When suppuration has occurred the knife is the only remedy. The superficial ones, invariably caused by an abraded surface, do not demand separate consideration. Incisions for relief of mammary abscesses should, wherever possible, avoid the areola, as cicatricial contractions in this tissue may deform the nipple and thus interfere with subsequent nursing.

**INTRA-GLANDULAR ABSCESES.** The intra-glandular are most commonly due to infection through mucous membrane, and if neglected may lead to the destruction of the entire gland. Free incisions in a direction radiating from the nipple, wherever necessary to insure perfect drainage, the introduction of drainage tube and the application of a moist dressing are required.

**RETRO-GLANDULAR ABSCESES.** The retro-glandular abscesses may be distinguished by the breast being prominent and immovable, the fluctuation being usually detected first at the lower and outer quadrant. The first incision should be made over the fluctuation, the surgeon introducing the index finger to determine the extent and the direction of the destruction and making counter incisions over the finger wherever there is a tendency to the formation of a pocket. The openings should be sufficiently large to introduce drainage tubes.

**Inguinal Abscesses.**—The inguinal glands are in two groups; superficial and deep. The superficial are again divided into two, one above and the other below Poupart's ligament. In the lower or vertical group the cause will be found somewhere in the lower limb or superficial perineum, while in the upper or horizontal group the cause should be sought for in the external genital organs, along the buttocks, or the lower part of the abdomen.

The only special direction in regard to their treatment is that in the supra-inguinal glands incision should be made at right angles to



Poupart's ligament. The tendency to inverted edges and retained discharges, so marked if opened in the direction of longitudinal fibres, is thus overcome. It must not be forgotten that these glands communicate directly with those following the external and common iliac arteries, so it is best not to wait until they are secondarily involved.

**OTHER VARIETIES.** There are other varieties of abscesses located around the groin not of a glandular nature but which are very interesting as well as important. Those which especially demand attention are: First, those pointing above the outer two-thirds of Poupart's ligament and secondary to perforative appendicitis; Second, those making appearance at the insertion of the ilio-psoas muscle, usually traceable to involvement of the lower dorsal or upper lumbar vertebræ; Third, those involving the pre-vesical tissue or space of Retzius; Fourth, those appearing just below the anterior superior spine of the ilium, always suggestive of inflammation within the sheath of the muscle, disease of the ilium itself or of the sacro-iliac joint. These latter varieties are easily treated by vertical incision and drainage. The others will receive attention in the departments of regional surgery and demand no consideration here. This is equally true of peri-renal suppurations, suppurations about the orifices, and purulent collections within the natural cavities.

**Complications of Abscesses.**—Some of the conditions which have been spoken of as abscess complications are hemorrhage, degeneration into a sinus or fistula, systemic involvement from absorption and general intoxication.

**HEMORRHAGE.** This is not a frequent complication, the living blood vessels being particularly resistant to suppurative disintegration. The most frequent result in the suppurating area is the formation of infective thrombi, parts of which, as has already been said, may become detached and carried as emboli to other parts, only to become arrested and form secondary abscesses. Still, it can be easily understood how hemorrhage might occur from destruction of the vessel wall by the inflammation. Sudden distension of the walls of an abscess is always suggestive of such complication. It has no special significance unless the vessel be very large, as the increased pressure from the accumulation soon controls it. The systemic symptoms will be taken up later under such headings as septicæmia, pyæmia, etc.

**FISTULA AND SINUS.** Of the complications of acute abscess which have been enumerated only the third need be here considered, i. e., degeneration into a sinus or fistula. These two words are often used synonymously; but in truth the term sinus applies to a suppurating tract with but one opening, while a fistula is either an abnormal connection between two natural cavities or between one natural cavity and the surface. It frequently retains the name after all the signs of inflammation and supuration have subsided. In general it may be said that a sinus is a suppurating track lined with a false membrane, usually leading to a granulating cavity. The cause is most commonly an improperly drained abscess, which may result from too small an opening or one improperly placed; want of rest; the presence of a foreign body or failure in complete asepticism. The same definition may at times apply to a fistula, but not always, and fistulæ more frequently result from a wound or from an

ulcerative or sloughing process. The special forms, such as fistula in ano and vesico-vaginal and recto-vaginal, are described elsewhere.

*Treatment.* Find the cause and remove it. If an inadequate opening; supply the deficiency. If a foreign body, remove it; if a stricture of some outlet, dilate it. These simple measures with perfect cleanliness will often suffice. Should they not do so, dissect out the false membrane, curette the cavity thoroughly until perfectly healthy tissue is reached and then, if possible, unite the surfaces by suture. If impossible, an iodo-formized gauze tampon must be used. If the patient will not submit to operative treatment the injections of strong solutions of nitrate of silver, iodine, chloride of zinc, carbolic acid, or peroxide of hydrogen will sometimes destroy the microbial colonies so that union of the opposing granulating surfaces may be expected.

## CHAPTER VI.

### ULCERATIONS AND ULCERS.

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**Distinctions.**—Ulceration is suppuration upon the surface, either of the skin or mucous membrane, and hence it may be defined as the molecular disintegration of superficial tissues. The process does not differ from that which has already been studied, but as it occurs on the surface and can be so much more readily studied perhaps it is well to briefly review the changes. The tissues at the central focus of the inflamed area become infiltrated with serum and the leucocytes begin to escape, wandering through all the structures and even into the epithelial cells. As the result of the irritation and consequent hyperemia proliferation of the epithelial cells is very active, and, being subjected to contact with serum, these are pushed forward before they have time to assume their horny character. This softened and sodden epithelium is easily rubbed off, leaving a raw and exposed dermis from which leucocytes and serum escape in abundance.

They thus relieve the tension and the reparative process would begin at once were the surface kept aseptic. But it is at this time usually that infection with pyogenic cocci takes place, and owing to the increased irritation the exudation becomes more free and the vessels here and there become thrombosed, thus cutting off the blood supply to the central portions, which, in their feeble condition, are so poorly resistant that the microbes have no difficulty in causing their liquefaction and disintegration. The process spreads little by little by the production of limited areas of stasis, but when the inflammation is very violent and spreads very rapidly, and there is not sufficient time for this molecular disintegration, the tissue comes away in large pieces called sloughs and the ulceration has changed to gangrene. The process is limited in the same way as in abscess formation, by dense walls of closely packed cells and the attenuation of the virulent microbes. These cells, after the active inflammation has ceased, become vascularized into granulation tissue, a process which will be more definitely described in the chapters devoted to regeneration and repair. Formerly the term ulcer was restricted to the denuded surface caused by a superficial suppurative inflammation, but modern nomenclature classes under this heading any sore left by the destruction of the superficial parts, regardless of causes. It is quite discouraging to take up the different works on surgery and read the different classifications authors have given. To say the least it gives a partial excuse for the carelessness or ignorance displayed in the treatment of these cases by many general practitioners, and for the many cure-all salves, so largely used even at the present day. It seems that in most things the simplest is the best; it certainly is in both the description and treatment of ulcers.

Any classification according to local conditions alone is misleading, because, unless the sore remains stationary under treatment the diagnosis will have to be changed too often to be truly scientific. It would then



necessitate such an interminable number of kinds that it would task the brightest mind to remember the names alone. Taken all in all the classification based upon causes is the simplest and most satisfactory. It must be borne in mind that inflammatory processes whether occurring in superficial or deep parts are essentially the same. This is true not only regarding causation but also in progress and termination. Excluding malignant ulcerations, which will be considered with tumors, over ninety per cent. of the ulcers the surgeon has to deal with owe their origin to inflammation which may have had its beginning in the skin or in the subcutaneous tissues. The remainder of them are traumatic. Upon this basis this subject will be considered, and it should be remembered that it is of just as much importance here as in deep inflammation to keep in mind the two important factors, first, the causes, both predisposing and exciting, second, the character of the sore and its local surroundings. The treatment will be much more satisfactory if these points are borne in mind and a correct diagnosis made in the beginning. Ulcers are divided then, into two classes, simple and infective. The infective may be further subdivided into the suppurative, the syphilitic and the tubercular. The causes have already been mentioned under inflammation. Whatever the exciting cause there may be a predisposing one and this, in the majority of cases, is malnutrition of the part, whether it result from local or constitutional causes. In deciding upon the local condition of ulcers, the points demanding the closest observation are the location, the appearance of the base, the character of the edges, the shape and number, and, last, the character of the discharge.

**Simple Ulcers.**—These are also called traumatic, as traumatism is almost invariably their cause. The injury is sufficient to destroy the parts and to detach them from the surrounding tissues. The force of the blow may have been so directed that the deeper structures suffer very slightly, or the inflammation excited in them by the injury may be sufficient to cause a further destruction of tissues. As a rule, unless the wound becomes infected, there is shown but little tendency to spread. They may occur anywhere and in any shape and number. The appearance is that of the surgically healthy wound in which primary union has not occurred. The base of the ulcer is filled with healthy granulations, the edges slope gently, the margins are of that delicate bluish-white indicative of commencing cicatrization. The discharge, if any, is simply the exudation of simple inflammation, mostly serum and leucocytes.

**TREATMENT.** In treatment, these ulcers require really nothing. If kept free from irritation and protected from access of micro-organisms the inflammation subsides and cicatrization soon seals the wound. If from the injury the surrounding skin is widely inflamed and the margins infiltrated with the effusion, multiple punctures may be demanded as a relief from the destructive tension.

**Varicose? Ulcers.**—Simple ulcers as described above are rarely seen in general practice because, in the first place, either through carelessness or ignorance, these traumatic abrasions become the seat of infection and, in the second place, if they occur in healthy parts, where the circulation is good, the healing is so rapid that micro-organisms have no chance to develop and the surgeon is not sent for. Suppose, however, a defective circulation in the part, as for instance, an eczema or, better yet, a mechanical

hyperemia. Here the veins have become weakened, either from a diseased condition or from constant obstruction to the return flow; they dilate, the valves become unable to perform their functions, circulation becomes slowed and finally partial stasis occurs, a condition described as varicose.

The enlarged veins interfere also with the circulation through the lymphatics, and edema becomes a prominent symptom. The transudation makes the skin sodden, the compression lessens still more the activity of the cells and the parts are in a state of such diminished vitality that they cannot react readily from any traumatism. The result of an abrasion on such tissue is a simple chronic ulcer. It is described as cold, chronic, feeble, or indolent ulcer, and by many other names, all indicating a condition of the tissue that makes ready healing impossible. What is the sequel? Great care is taken for a week or so and then the bandages are less carefully applied and the discharges allowed to collect and undergo putrefaction. The result is a septic or infective ulcer, for the suppurative process is usually added to the putrefaction. These are progressive or stationary, as the reparative process is less or equal to the degeneration. The additional inflammation as a rule, however, still further interferes with the nutrition of the diseased tissues, which can offer little resistance to the extending destruction. All surgeons are familiar with the dark blue color of its base, the thickened and inverted edges, the readiness with which it bleeds, the mottled, sodden look of the surrounding tissues and the offensive irritating nature of the discharge. They should not be called eczematous or varicose ulcers for they are not. These are simply conditions which locate a dermatitis, at first simple, later infective in its nature.

**TREATMENT.** The indications for treatment are two: Support of the circulation, reduction of the inflammation. First, the part is cleansed thoroughly with warm water and soap, removing inspissated discharges and effete epidermis by application for twenty-four hours of a two per cent. solution of carbolic acid in glycerine. Then it is cleansed with a weak antiseptic solution, preferably common salt, boracic acid or acetate of aluminum, all the disintegrating tissue being carefully removed, either with a curette or with the scissors, and the edges trimmed off if they show the tendency to become inverted. Compresses saturated with Thiersch's solution are also effective and may be continued for days. The support to the circulation is of primary importance and is best attained by the recumbent posture, with elevation of the limbs and the removal of any obstruction to the return of venous blood. With the limbs so elevated the circulation improves markedly and the exudation soon becomes absorbed.

When the decomposing tissues are done away with and the parts maintained free from further infection there is nothing to perpetuate the inflammation. The part should be dusted thickly with iodoform, a layer of protective silk, a little gauze and a light flannel bandage should be placed over it. It is unfortunate that we can so rarely treat these ulcers as we wish in private practice. The patients are as a rule from that station in life where lying in bed is a luxury not to be considered. They are obliged to work.

The next best way of reducing the edema and supporting the circu-

lation is by the application of a thin sheet of rubber bandage or a semi-elastic bandage of fine flannel. These should extend with even pressure from the extremity several inches above the diseased area, should be applied before getting out of bed in the morning, then be removed and the parts thoroughly cleansed before retiring. The study of the individual case must decide the surgeon in the choice of the dry or moist dressing. The dry applications are aristol, iodoform, subnitrate of bismuth, boracic acid, c. p., or a five per cent. trituration of salicylic acid. They should be dusted on the ulcer, covered with a smooth layer of lintine and a bandage applied.

Of the moist or oleaginous applications, the carbolated glycerine or cerates of zinc-oxide, iodoform, carbolic acid, mercury or unguentine are useful. If the ulcers are very painful opium or cocaine may be added to allay the suffering. Ichthyol, ten per cent., is often excellent in eczematous conditions. If this is not sufficient to promote healthy granulation the use of mild irritants is called for, of which the author prefers Balsam of Peru or nitrate of silver. Where both antiseptics and irritants fail, beneficial and rapid results may at times follow the use of Bovinine poured directly upon the granulating surface, which is then protected by a gauze compress. The dressing should be changed two or three times daily.

Excessive granulations are best reduced by compression. If necessary, they may be touched with nitrate of silver. The strapping of these ulcers is not so much in vogue now as formerly, elastic compression having superseded it.

After cicatrization is complete the support afforded by a flannel bandage snugly applied, or by an elastic stocking, is usually sufficient, in conjunction with proper cleanliness, to prevent a recurrence of the trouble. It must not be forgotten that the varicosity is only the predisposing and not the actual cause, and that the support of these veins by a semi-elastic bandage is the best preventive measure to adopt. Sometimes, however, it may be necessary to extirpate portions of the varicose veins. Septic ulcers in any part of the body from direct infection may follow; or they may result from deeper inflammation, such as abscesses. The treatment is free removal of diseased tissues and antiseptic after-treatment, removal of the cause and correction of constitutional predisposition.

**Syphilitic Ulcers.**—This is another form of inflammation due to micro-organisms. In speaking of this variety the primary sores are not included. The surgeon has to do with those of secondary and tertiary stages, and it is necessary to be explicit in description and diagnosis, for a recognition of the cause and consequent general or constitutional treatment are of equal importance with the local.

Ulcers of syphilis have characteristics, any one of which may be sufficient to point out the direction for inquiry.

*Location.* Though these ulcers may occur in any part of the body they seem to have a predilection for certain localities, as the skull, the sternum and the outer side of the leg above its middle.

*Shape.* Those of secondary type, resulting from ulcerating papules, are commonly round, but when several coalesce it gives a sinuous appearance rarely seen save in syphilitic subjects; they are termed serpiginous.



Still more characteristic is the crescentic ulcer, which heals at the concave and spreads at the convex border. These usually result from a breaking down of small gummata, the so-called syphilitic tubercle. Larger gummata are round or oval in shape. The history of a painless swelling of this form wherein the overlying skin becomes inflamed and disintegrates gives an almost positive proof.

*Number.* Syphilitic ulcers may be single or multiple; if multiple, there seems to be a tendency to involve like parts on the opposite sides of the body.

*General Character.* Though not positively diagnostic, steep, sharp-cut edges, giving the "punched-out" appearance, are very frequent; the base is almost devoid of granulations and frequently covered with a yellowish-gray slough, which has been described as the "wet wash-leather slough"; or the discharges drying form a hard, conical scab beneath which are thick, large, grayish, or mottled granulations. The edges are sometimes very callused, but the surrounding tissues are healthy and not infiltrated. Pain attending this form is slight.

*TREATMENT.* As before hinted, the constitutional treatment is all-important. The best and most prompt results have been from mercurials and iodide of potash; locally, the strictest cleanliness and free use of antiseptics. As dry applications, iodoform or calomel, sublimated mercury and boracic acid 1-2000 are the best. Ointments of mercury, either red or yellow oxide, or lard with 1-1000 of bichloride of mercury, after the removal of all disintegrating tissues, are very effective. The cicatrices formed are nearly always deep and pigmented, but this pigmentation is not diagnostic, as it may follow chronic inflammatory ulcers due to pus infection.

**Tubercular Ulcer.**—Cutaneous tuberculosis most commonly appears in one of two forms; First, after rupture of a tubercular gland; Second, as lupus. In the former, the location, the shape and history of glandular enlargement, the flaky, oily discharge and the excessive flabby granulations, the purplish margins and undermined edges, are all characteristic.

Lupus will be described later under the head of tubercular inflammations, for that it is a cutaneous tuberculosis has been proved beyond a doubt by cultivation and inoculation experiments. Its progress is slow except when complicated with pyogenic infection.

The modern surgical treatment of local tuberculosis is identical with that accepted for the cure of malignant new growths. It consists in the more or less complete removal of the affected tissue or organs by caustics, the knife or gouge under antiseptic precautions.

Extensive ulcerations which refuse to heal in spite of all efforts, or in which dermatization is impossible, may be greatly hastened by means of skin grafting. When located upon an extremity and where all methods fail to cure amputation may be demanded.

## CHAPTER VII.

### ERYSIPELAS.

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Erysipelas is an infective or spreading inflammation involving most commonly the skin, but occasionally the mucous or serous membranes. There are two kinds described, simple or cutaneous, and phlegmonous or cellulocutaneous.

**Etiology.**—Erysipelas is a local disease with marked constitutional symptoms. It invariably arises from without, from the introduction of the streptococcus of Fehleisen through an abrasion of the skin or mucous membrane. Inoculation experiments have demonstrated the period of incubation to be from fifteen to sixty hours, in which time the slight abrasion may have healed so completely as to be undiscoverable. That it exists is certain, for the microbe has no power of penetrating a healthy skin or mucous membrane, though it possibly may penetrate tender scar tissue of new formation. There must be a predisposing cause which results in a lessening of vital cell activity. The progress is limited according to recent investigations (Rochford and Mestschnikoff) by phagocytosis, the activity of the connective tissue cells and leucocytes which, in their antagonism to the micro-organisms, give rise to the production of a chemical poison inimical to the parasites.

**Simple Cutaneous Erysipelas.**—May be correctly called a migrating dermatitis.

**PATHOLOGY AND SYMPTOMS.** The microbes entering as has been described begin to multiply and their irritation excites a round celled infiltration similar to that of any inflammation, save, perhaps, a preponderance of the connective tissue cells over the leucocytes. They spread by the lymphatics, chiefly, or rather, in preference, by the superficial ones of the corium, and the spaces contributory to them. They produce acute inflammation of these channels, giving the characteristic signs of acute inflammation; so, in reality, erysipelas is an infective lymphangitis, the peri-lymph spaces becoming involved by contiguity of structure.

The neighboring glands come under the microbial influence, becoming painful, tender to the touch and slightly swollen. The spreading edge is sharply defined on account of the cell infiltration, and it is at this point that the micro-organisms can be found most numerous and active, waging war against the resisting cells. At times the acuteness of the inflammation causes a separation of the cuticle from the true skin in the form of vesicles or blebs—vesicular erysipelas. Again, the spread may be so very rapid that large portions of skin come away in sloughs, owing to the complete locking up of lymphatic and connective spaces by the rapidly multiplying cell microbes—gangrenous erysipelas. The redness is usually very vivid and uniform, the pain stinging and burning, the edema extensive in proportion to the laxness of the tissues, giving that characteristic shiny appearance. The receding edges fade off into

healthy tissue, microscopical examinations discovering an occasional microbe in the leucocytes and fragments of those destroyed in the connective tissue cells. Some desquamation usually follows.

The constitutional symptoms are proportionate to the extent and rapidity of the progress of the local disease and do not depend upon the micro-organisms, for they rarely enter the blood in sufficient numbers to account for the symptoms, but upon the products of the disintegration the germs cause. That microbes do enter the blood at times is positive. This will be referred to as causative of so called metastatic erysipelas. In reality the constitutional symptoms are those of septic intoxication, the introduction being gradual, however, and in such small quantities it is not so rapidly severe and exhausting. They begin almost invariably with a chill, and rise of temperature, which rises in very few hours to 102 degrees to 104 degrees and is continuous, with very slight morning remissions, in cases uncomplicated by suppuration. The fever continues as long as the disease is progressive but ceases with the limitation.

DIAGNOSIS. As a rule no difficulty presents. Simple erythema is not uniform but occurs in spots with healthy tissue between. In erysipelas the process is uninterrupted and the constitutional symptoms are alarming. In lymphangitis, from other than erysipelatous infection, the disease involves other and larger lymph vessels, and instead of a uniform redness the inflammation appears as streaks running from a primary poisoned wound, the true skin not being involved in the process.

The greatest difficulty will be in its differentiation from a phlegmonous inflammation, for, as has already been said, their microbes are very similar. This differentiation will be made when the second form of erysipelas is considered.

TREATMENT. The successful treatment depends (a) upon the power to destroy the organisms and so check the spreading, or (b) the improvement in the general condition, thus aiding nature to overcome the disease. In other words, the treatment should be local and general, remembering that the local symptoms are due to the micro-organisms, the general to the septic intoxication.

In considering the value of remedies so highly praised for the local and internal treatment of this disease the fact must not be overlooked that in the vast majority of cases nature is sufficient in herself to overcome the disease. In other words, the disease is frequently self-limited, tending to recover without treatment in from five to seven days, though it may last much longer.

The general treatment must be to increase the resisting power of the tissues and it is not believed that this can be done by starving the patient. He should be fed and fed all he can comfortably take care of. The action of the food on the patient rather than preconceived notions should be the guide in the selection.

Local treatment aims at the destruction of the germs and prevention of the spreading, improvements in both of which can be accredited to surgical bacteriology and antiseptic surgery. The most successful methods of preventing the spread are based upon the fact that this takes place through the superficial lymphatics and the lymph spaces, and consequently obliteration of the canals must prevent diffusion. The method was first advocated by Wolfer, who applies adhesive straps above and around



the diseased area sufficiently tight to compress the lymph channels and so circumscribe or imprison the destructive germs. He cites the history of eighteen cases, in twelve of which the disease never extended beyond the straps, and in most of those in which it did he discovered a faulty application of the same. This extension never attained the virulence of the encircled area and was easily controlled by another strap two or three inches above the first. Kroll thinks the adhesive straps do not exert sufficient pressure, and recommends the use of elastic bands. Collodion is equally effective. The use of either, combined with the antiseptic fomentations, will in the majority of cases be sufficient. Where these means are ineffectual the operative treatment introduced by Kraske for the purpose of bringing the germicidal fluids into direct contact with the microbes should be used. The original method has been somewhat modified and consists of numerous fine incisions two inches from the border of the erysipelas, completely in the healthy tissues; these are crossed diagonally by others, giving the appearance of a rail fence around the diseased area. The operation is done under strictest antiseptic measures, and the wound is kept continually moist with a 1-2000 bichloride solution for several days. In only rare instances does the disease extend beyond this line, and can then be traced to making the incisions too close to the diseased area beyond which there were, no doubt, microbes already located. If there is difficulty in getting the consent of the patient to an operation which demands an anesthetic, Seibert has substituted scarification of the healthy tissues surrounding the diseased area with a vaccination comb. This can be done without an anesthetic and in a very short time, the scratches being just deep enough to draw blood. Supposing the disease is on an extremity the whole limb is bathed and scrubbed and the diseased area covered with a disinfected towel; then, choosing a place about one and one-half or two inches above and below the diseased area, a vaccination comb, made especially for the purpose and about an inch wide, is drawn around the whole circumference, scratching its way into the true skin; these lines are crossed diagonally or at right angles by others, so as to open the skin for an inch. This denuded spot is then kept in constant contact with a sublimate solution, 1-2000.

Where operative treatment or compression cannot well be used, as, for instance, on the face, local applications less irritating than corrosive sublimate must be employed. My own best results have followed the use of saturated solutions of boracic acid with compresses kept constantly moist, or ichthyol in water in all strengths from ten to twenty per cent. and painted upon the parts with a camel-hair pencil every hour or two. These certainly control the burning and itching and retard the spreading. In facial erysipelas the original point of inoculation must not be overlooked. It will most commonly be found in the nasal mucous membrane, which should be kept scrupulously clean by use of an atomizer and Listerine, or some equally mild and good antiseptic.

PROGNOSIS. The prognosis in uncomplicated cases is usually good in the cutaneous form, the so called facial erysipelas being the most dangerous for two reasons: First, it is not open to the best surgical treatment; second, the possibility of direct extension to the meninges of the brain following the course of the blood vessels. When rapidly spreading the

constitutional symptoms may be severe enough to cause dissolution. In erysipelas of mucous membrane the prognosis must be guarded, as secondary pyogenic infection is so difficult to prevent.

As has already been said erysipelas sometimes involves serous membranes, most frequently those of the brain; sometimes, as in the facial variety, this may be from direct extension, but, as a rule, such involvement of serous membranes is metastatic.

This metastasis may result at a distance from the original focus of the disease, either from the germs being carried in the lymph stream, to become arrested in favorable soil elsewhere, or by means of infected emboli in the blood stream. In the former case there would, of necessity, be a lymph connection between the two parts.

**PHLEGMONOUS OR CELLULO-CUTANEOUS ERYSIPELAS.** This is a form in which the subcutaneous connective tissue is involved as well as the skin. It often results in extensive sloughing from rapid extension and cutting-off of the blood supply.

**ETIOLOGY.** Having said that all cases of erysipelas are due to the streptococcus erysipelatis it may be thought unnecessary to go into the causes of this form, but there is an interesting question to be considered in this connection. Can the microbe of erysipelas cause suppuration, which is so constantly present in what is termed phlegmonous erysipelas? Bacteriologists are still disputing on this point, but experimental inoculation with the streptococcus erysipelatis and the streptococcus pyogenes in pure cultures would tend to prove that they act differently on the tissues. The microbe of erysipelas is found always in the lymphatic vessels, sometimes in the connective tissue spaces, very rarely about or in the blood-vessels, never in the deeper tissues. That of suppuration migrates into the deeper tissues and is nearly always found not only about but within the substance of blood-vessels. Experimental research has convinced Fehleisen that inoculation with germs of erysipelas is never followed by suppuration, and, also, that pyogenic cocci never produce true erysipelas, and Hojick, in fifty-one inoculations in rabbits with pure cultures of streptococcus erysipelatis, succeeded in producing only a migrating dermatitis, never suppuration. The weight of evidence seems in favor of Fehleisen's views, and until better proof is offered to contradict it phlegmonous erysipelas must be regarded as a mixed infection.

There is no doubt that a great many cases of so called cellulocutaneous erysipelas are no more than diffused suppurative inflammations, and the differential diagnosis must depend largely upon the location of the primary focus. In erysipelas this is invariably in the superficial lymphatics of the true skin, and any involvement of the subcutaneous structures will come later and must be regarded as a secondary complication. In phlegmonous inflammation, on the other hand, the beginning is always in the subcutaneous connective tissue and the involvement of the skin and lymphatics will follow upon the symptoms of deeper seated inflammation and exudation. The pain in erysipelas is burning and smarting in character; that of the phlegmon dull and throbbing in its nature. The fever in erysipelas is continuous, that of suppuration remittent in type.

**PATHOLOGY AND SYMPTOMS.** In the early stages the process is similar to that already described. When secondary infection takes place, and the connective tissue is extensively involved and the circulation neces-

sarily markedly interfered with the difference is very appreciable. This secondary infection occurs most commonly through the blebs which the intensity of the erysipelas may have caused, and from here the microbes invade the connective tissue. The redness becomes darker and the edges sharply defined on account of the increased edema; the extension goes on more rapidly; to the smarting and burning is added the dull, throbbing pain; large areas of skin become undermined with pus and assume a purplish mottled expression, showing the low ebb of its vitality. If not relieved soon the probability of sloughing is very great. The constitutional symptoms are more marked than in the superficial from the amount of poison introduced being greater. They may assume the characteristics of septicemia or pyemia, gradually deepening into a low typhoid type, the character depending largely upon the amount of suppuration complicating the original lesion. A sudden increase in the temperature of a case of erysipelas should always place the surgeon on his guard for this complication.

TREATMENT. It is hardly necessary to speak of treatment, having devoted so much space to the treatment of diffused suppuration and to that of simple erysipelas. Obviously their judicious combination is the proper plan to adopt. Searification will have no effect whatever in controlling suppurative process extending along the connective-tissue planes, but where there is the mixed infection this method, in conjunction with the free longitudinal incisions recommended in infective inflammations, and the careful use of antiseptics, will make a satisfactory therapy. The surgeon must not wait until pus has formed, but as soon as it seems inevitable, as soon as satisfied that milder means are not controlling the disease, as soon as edema becomes so marked that death of the tissues seems probable, numerous longitudinal incisions should be made, keeping the lips of the wounds apart by means of strips of gauze or oil silk and then applying antiseptic fomentations, changing frequently enough to keep the parts constantly bathed in the solution.



## CHAPTER VIII.

### TUBERCULAR INFLAMMATION.

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**Etiological Considerations.**—The third variety of infective inflammations viz.: Tubercular, is one of the greatest interest. The clinical forms of surgical tuberculosis, which will be most frequently met with and which do not belong especially to regional surgery, will be described later.

No matter in what tissue tuberculosis may originate its development is typical of a chronic inflammation. In importance and frequency it is second only to the acute suppurative inflammations just considered and, as will be seen a little further on, the two are very apt to be associated. Nearly all of the former conditions grouped under that rather vague term "Scrofula" are recognized now, both in a clinical and pathological way, as forms of tubercular disease.

There are few surgeons of intelligence at the present time who doubt that the true cause of tuberculosis, whatever the clinical form, is the bacillus of Koch.

The main difference cited between acute and chronic inflammations aside from the activity and duration is that while in the acute form the exudation of leucocytes and serum was of primary importance it was secondary to cellular formation in the chronic. Nothing could impress this more firmly on the mind than the histogenesis of tubercle. In speaking of tubercle a nodule or granule is meant which is composed of cells of different sizes blended together, generally in concentric form. The primary origin of these cells depends upon the mode of infection, and as this is most commonly through the lymphatics it is probable that the original cells are often the endothelial cells of the capillary lymphatics or lymph spaces. Tubercle bacilli circulating in the blood have the peculiarity of becoming incorporated in white blood-corpuscles, and as they have no motile power it is probably by means of the extravasated leucocytes that the micro-organisms gain entrance into the fixed tissues. Suppose now that such a corpuscle with its incorporated bacillus becomes arrested in the tissues which have a lessened power of resistance, it becomes attached to a capillary wall, where the action of the microbe is sufficient to convert the endothelial cell into a larger cell termed lymphoid. The bacillus begins to multiply and produce its characteristic effect upon the tissues. This is a chronic inflammation. The original lymphoid cell becomes surrounded by rings of leucocytes and connective tissue cells. The latter, as they come under the influence of the germs and their ptomaines become converted into lymphoid cells, which latter, in turn, undergo degenerative changes, and are utilized as food by the central cells which, still enlarging, form multilocular giant cells containing large numbers of bacilli. As these changes occur in the central area the round-celled infiltration of inflammation composed of leucocytes and new fixed cells forms about them. The whole is a tubercle, and though they are not always

typical, as just described, it is well to remember these three zones: First, an external, composed of small round cells; second, a middle zone composed of epithelioid or lymphoid cells enmeshed in fibres, part of which are connective tissue, part newly formed fibrous processes from the giant cells; third, an internal zone containing one or more giant cells which have grown to such proportions by taking up a greater amount of nourishment, most likely the degenerated leucocytes.

Tubercles are most commonly spoken of as the gray and the yellow. Gray or miliary tubercles, sometimes called gray granulations, are firm, rounded, semi-translucent bodies varying in size from a pin-point to a pinhead; they are distinctly separated the one from the other. In their degeneration they form yellow tubercles which appear much larger, often forming masses as large as a pea or a hazel nut. The size is not due to enlargement of individual tubercles, but to degeneration and blending together of several neighboring ones. The degeneration is first a fatty one; it begins centrally and gives the difference in color between the gray and the yellow.

Each tubercle enlarges by proliferation of its cell elements, new ones are formed by infection of surrounding structures, by means of leucocytes in which the bacteria lie, or by being conveyed by the lymph stream into connective tissue spaces. As said before, the origin of the cells in a given tubercle depends upon the character of the fixed tissues invaded. As these tubercles increase in size and number they coalesce, forming a well defined tubercular lesion. As the result of the irritation and pressure of tubercle there is always a zone of hyperemia and increased cell-activity, and as the normal connective-tissue of the parts become pressed aside by the advancing growth these new cells are filling in the spaces and becoming converted by the formation of new capillaries and enlargement of old ones into a layer of granulation tissue. This eventually forms a well defined wall around the focus of inflammation and as long as it remains impermeable the disease is localized.

The formation of granulations is characteristic of tubercular inflammation, but when infection of neighboring structures occurs before its formation it, of course, does not circumscribe the disease.

**SECONDARY CHANGES.** The changes in the tubercle itself are degenerative and the most frequent is that which is termed caseation. This begins as fatty degeneration in the central portion, and is owing partly to non-development of new blood-vessels, and obliteration by pressure of many of the old ones, and partly to the direct action of the bacilli and their ptomaines. The destruction is usually a slow process, the rapidity depending upon the distance of the center from the blood supply. When slow the microbes usually die from want of nourishment, the fluid becomes absorbed, the cell element drying up into a cheesy-like substance, which may remain thus encapsuled for an indefinite time. Usually, soon or late, new inflammatory exudate gives the retained spores a soil suitable to their development. Sometimes, however, the caseated tissue becomes the seat of a deposit of earthy salts, resulting in so called calcareous degeneration.

This is the usual termination in tissues, comparatively strong and resistant; but when weak and diseased, when the process is more rapid, the bacilli do not die but attack the wall of granulation tissue and by

their irritation cause an increased exudate of serum and leucocytes, which, with the caseous or fatty matter of degeneration, forms an emulsion termed tubercular pus. Thus there is formed another degenerative change, the chronic or tubercular abscess. The contents of this abscess differ from the acute abscess to the naked eye in being whiter and thinner, more nearly resembling milk, holding in suspension particles of the yet unsoftened caseous matter, "bone sand," and possibly grit from deposit in small foci of the calcareous salts. When such an abscess ruptures or is opened the cavity is found to be lined by a thick layer of purplish granulation-tissue, the formation of which has been explained. Close inspection will reveal numerous minute yellow spots, showing the location of the still existing tubercular infection. The tissue is so loosely adherent to the surrounding tissues that it is easily detached with a curette. In operating upon these cases its entire removal is essential to a complete cure, thorough healing being impossible as long as a remnant remains.

**FIBROID CHANGE.** Another important change in tubercular degeneration is termed the fibroid change. This really signifies that the tissues have been victorious in their fight with the germs, the central portion of the tubercle undergoes a fatty degeneration and is absorbed, and the layer of round cells between the diseased focus and healthy tissue becomes converted into firm fibrous structure similar to, indeed identical with, scar-tissue. In this scar-tissue, if examined microscopically, may be found minute foci of fatty degeneration, and while they are not necessarily infectious in their nature they may contain enough spores to develop if proper conditions obtain.

**Bacillus Tuberculosis.**—Before taking up the clinical forms of this disease, which belong to this department, perhaps it will be as well to say a word or two more about the bacillus tuberculosis which is the essential though not the only requirement in its production. It is the smallest of known bacilli that affect man and is found both straight and slightly curved. It may occur singly, doubly or in groups and, as we have seen in a developing focus, occur in large quantities in the giant cells, in the epitheloid cells and in their interspace. It develops rather slowly by sporulation, and in cultivating media it is found that reproduction occurs only between 86 F. and 105 F. It has no motile power and must be conveyed into fresh areas by the leucocytes and the exudation stream. It is most numerous in actively growing nodules, there being very few, if any, in caseous degeneration, those foci owing their virulence to spores, of which there are usually two to six in each active rod. These retain their power indefinitely.

Local tuberculosis occurs without doubt most frequently by way of the lungs. These may be the seat of a primary tubercular disease, or catarrhal conditions of the bronchial mucous membrane, and the consequent denudation of epithelium may serve as portals of infection for floating microbes, they being carried either directly into the circulation or, as Gerster points out, becoming arrested and developing in the bronchial glands. This latter mode is especially liable in children, following measles and whooping cough.

**Tubercular Abscess.**—Something of this form was mentioned when dealing with acute abscesses and the method of their formation



has just been spoken of. The objects of attainment in treatment are the same as in acute abscesses. The dangers both during and after operation should be borne in mind, especially in those abscesses which are a long distance from the real seat of the disease. These cases are among the most doubtful of surgical diseases; that is, we can be less sure of preserving asepticism. Roughness of manipulation in efforts at the removal of the lining membrane may be the means of forcing tuberculous matter into the mouths of open veins and thus leading to systemic tuberculosis, or at least an extension of the local area of disease.

In operations upon abscesses occurring far from the real seat of the disease, as in psoas abscess, and there seem to be contra-indications for counter incisions at their origin, the best that can be expected is a long tedious recovery, and secondary infection with pus microbes confronts during all these weeks. Should such infection occur an increase in the rapidity of tissue changes, with higher and more active constitutional symptoms, will denote it. The superficial granulations are soon destroyed and the fresh tissues are exposed to the new enemy.

To secure the best obtainable results in these cases the two essentials are large incisions, to obviate the necessity of much blunt manipulation, and the strictest antiseptic precautions not only in preparation and at the time of operation but as long as the slightest sinus remains. It is in these cases that the aspirator is most useful. Whenever insecure in antiseptic methods aspiration, under strictest cleanliness, and injection of the cavity with the ten per cent. iodoform emulsion will be the best treatment. Of course the constitutional treatment in all tubercular diseases is of the utmost importance. It may be summed up in the few words, fresh air, good food and plenty of it, cod liver oil and constitutional homeopathic treatment.

**Tubercular Lymphadenitis.**—This form of tuberculosis finds a typical illustration in the cervical glands. The infection is usually a lesion in the nasal or oral cavities, though it occasionally results from surface wounds such as scratches or eczematous eruptions. Of course the glands primarily involved depend upon the seat of the primary abrasion, and as that is most commonly in the mouth the glands in the submaxillary region are usually attacked first. It is most commonly seen between the ages of ten and twenty years, though it may occur any time in life.

**PATHOLOGY.** The changes are characteristic, and already described. The miliary tubercle begins in the center, there is the slow formation of giant and epithelioid cells, and outside of this the infiltration of round cells and the zone of active hyperemia. Caseation begins in the center as usual and as the disease spreads the capsule of the gland grows thicker, partly from increased nutritive activity in the part and partly from condensation and adhesion of the connective tissue by the pressure. This capsule serves for a time as a very efficient protection to the spread of the disease and as both efferent and afferent lymph vessels are occluded by the round celled infiltration the disease is temporarily perfectly localized. The disease is however, as a rule progressive. In the superficial glands the extension may be toward the surface, the skin becomes involved in the inflammation and when rupture occurs leaves a tubercular ulcer. Much more frequently, however, the extension is to other glands

and the whole chain may become involved; peri-adenitis follows, the connective tissue becomes involved, and if not relieved, the patient is in constant danger of systemic involvement also. This systemic involvement, general miliary tuberculosis, may come from the lymph current, but if the location of the glands and their proximity to the larger veins be remembered it can readily be understood how perforation of those vessels might take place and tubercular matters be carried into the general circulation as emboli. Secondary infection with pus microbes is quite common and then the progress is much more rapid, as a rule, though cases are reported where the suppurative lesion has cured the tubercular disease.

**PROGNOSIS.** Even in the apparently very mild and slowly progressive cases the tubercular gland is always a source of danger. While spontaneous recovery is possible, either by resolution or by caseation and absorption, it can never be said that there are not certain spores retained waiting an opportunity to re-develop. Then, as has been said, progressive enlargement is the rule, though years may elapse before it is markedly noticeable. When many glands are involved the prognosis should be guarded.

**TREATMENT.** The present opinion of modern surgeons is very tersely expressed by Senn in these words: "Early operative interference is as necessary in the treatment of tubercular adenitis as in the treatment of malignant tumors, and holds out more encouragement as far as a permanent cure is concerned."

To be assured of success the operation must be undertaken early, that is, while few glands are involved and before the peri-glandular tissue is markedly indurated. When the latter condition obtains, or where acute suppuration has been added to the tubercular disease and periglandular suppuration exists, total extirpation is often impossible and the better treatment is free incision and the removal of the diseased products with a sharp spoon. After the patient recovers from his acute attack, the radical operation may be performed. In the extirpation of these glands, large incisions are very necessary; working in the dark is not good surgery, and every gland should be seen before its removal is attempted. They should be carefully dissected out with the knife or scissors, the capsule being preserved intact. When the deep as well as the superficial glands are involved the sterno-cleido mastoid may have to be centrally divided and reflected, and it is far safer to remove the whole chain without disconnection than to take each out singly. If the internal jugular vein is strongly adherent to inflamed glands and by dissection cannot be liberated it should be ligated above and below and the section removed. The important nerves in this region should not be forgotten. The spinal accessory is the one most apt to suffer, but if it should be divided, either intentionally or by mistake, primary suture will give satisfactory results as a rule. In suturing the wound the muscle should be accurately coapted with buried sheep-gut sutures. The superficial sutures must be carefully applied to prevent ugly scars, large drainage tubes being introduced at the upper and lower angles of the wound, with moist, antiseptic dressings, the bandage being applied with the head held in a position to relax the sterno-cleido muscle. In cases where large cavities are left it is best to change the dressing in twenty-four hours.

Drains should be removed as soon as safe and the wound be re-dressed permanently.

**Tubercular Tendo-Vaginitis.**—Though usually a combination of joint tuberculosis the disease of the tendon sheaths may occur primarily; the micro-organisms floating in the circulation are most likely arrested on account of some traumatism. The different products which the disease in this locality gives rise to are (a) numerous granulations, which occupy the inner surface of the tendon sheath with much or little increase in the fluid exudation, and (b) granulations in which are formed white masses termed the rice bodies which may remain attached, but more commonly are found as loose bodies.

This form of tubercular disease is most frequently seen about the wrist joint, either the flexor or extensor tendons of the fingers. When the deep flexors of the palm become involved the swelling often extends beneath the annular ligament up to and even above the wrist, distinct fluctuation being obtainable between the two points.

The pathology is the same here as elsewhere, excessive granulation, both on the sheath wall and on the tendon penetrating the latter, so weakening it that a slight muscular strain has been sufficient to rupture it; or the sheath may give way and the caseous matter, being thrown into the connective tissue, causes the formation of an abscess which may involve the fascia extensively. Another danger is extension along the sheath into the joint.

**DIAGNOSIS.** The differentiation between that form characterized by excessive secretion of synovial fluid and simple ganglion is made, mainly, in the more chronic course of the former and the fact that it is diffused and shows a tendency to spread while the latter is distinctly circumscribed and remains so. In the granulation form there is a slight swelling of a semi-elastic nature, which may or may not be attended by fluctuation. The only condition with which it might be confused is plastic tendo-vaginitis, in which there is a thickened sheath which remains so dry that movement of a tendon through it causes a typical friction sound. The disease is painless unless the swelling be sufficient to cause pressure symptoms.

**TREATMENT.** The only treatment from which very much can be expected besides radical removal is aspiration and injection of iodoform emulsion or iodoform solution in ether. The technique of the operation for the removal of the diseased tissue is its very careful dissection under antiseptic precautions. The external incision must be large so that everything that is to be cut can be seen. After dissecting out the limiting sheath the tendon is thoroughly scraped and then dressed. As soon as the wound is healed passive motion and massage will insure a good functional result in most cases. When acute suppuration is added to the already existing lesion free incision, antiseptic irrigation and curetting seem better than extirpation.

Tuberculosis of fascia and muscles does not differ enough from the above descriptions to demand separate consideration.

**Tuberculosis of Skin.**—The most common clinical variety is lupus vulgaris, which shows a decided preference for the face and hands. It results, in by far the majority of cases, from direct infection through some skin abrasion, and the tubercles develop at the point of inoculation.



It begins as a small red nodule in the true skin. The hyperemia it excites makes it appear very vascular, but it is neither painful nor tender. It develops slowly and new nodules appear in its immediate vicinity until finally considerable swelling results. As it increases in extent it involves the epidermis and the central portion, being exposed to most pressure and deprivation of nutrition, softens and breaks down. The ulceration spreads in the peripheral direction. This spreading is not very rapid unless secondary infection with pus microbes takes place, when it is quite rapid and destructive. Before the cause was recognized this rapidity of extension gave rise to the two descriptive terms of lupus exedens and lupus non-exedens. The ulceration may remain superficial, and simply destroy large tracts of skin, or it may involve the connective tissue and even the muscular structure, in which case the destruction is very great.

DIAGNOSIS. It is sometimes very difficult to distinguish between lupus, epithelioma and tertiary syphilis. A straight history either of syphilis or tuberculosis will be very significant; and still the fact must not be overlooked that a syphilitic subject may have tuberculosis, or that a syphilitic lesion may exist without an obtainable history. In cases of doubt it does no harm to place the patient upon an anti-syphilitic treatment until the nature of the case can be determined positively. A syphilitic lesion will show marked improvement in two or three weeks. The tubercular nature may, perhaps, be demonstrated by the microscope and the discovery of the bacillus, but at times there are so few in this form of disease that many specimens may be examined without the discovery of a single germ.

The most certain method is by inoculating a guinea pig by the introduction, subcutaneously, of a small particle of the granulation-tissue. The pig will die in from three to six weeks of general miliary tuberculosis if the disease is lupus. The history must tell the tale as between tubercular disease and epithelioma. The former begins in the true skin, is at first very vascular and only involves the epidermis later. In the latter the epidermis is primarily involved, it is not so vascular in the beginning and it infiltrates the layers beneath the epidermis as it enlarges. Lupus is firm and elastic to the touch, epithelioma is hard and inelastic. Lupus has more marked granulation and, under the microscope, the cells do not show the strict concentric and alveolar arrangement. Later the vascular changes are reversed, epithelioma becoming very vascular, lupus almost devoid of blood supply.

TREATMENT. The treatment is the same as that of tuberculosis elsewhere, if the disease occur where its complete removal is possible. The locality and extent must decide as to the choice of total excision or the removal by actual cautery or by means of the sharp spoon. In either case, where there is much sacrifice of tissue, the operation, if in the face, must be supplemented by skin-grafting or flap-transplantation. Local return of the disease is an indication for more thorough removal.

The clinical reports of the use of tuberculin in cutaneous tuberculosis are too conflicting to be conclusive. Time alone will give it an exact position.

## CHAPTER IX. NECROSIS.

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**Nomenclature.**—Necrosis has been mentioned as one of the results of inflammation, the spread of which is too rapid to admit of the liquefying process. While necrosis always signifies the death of a part, and is nearly always associated in the surgeon's mind with an infective process it must be remembered that there is such a condition as death of a part without putrefactive changes; that is, an aseptic necrosis. Even though this be true, and will eventually alter our nomenclature, necrosis, gangrene and mortification are terms which are used synonymously in even recent literature, and custom forces their consideration together here.

Necrosis is a condition of arrested nutrition and, whatever its apparent cause, it acts through one of two ways, by arrested circulation or destruction of cell function. The predisposition to necrotic changes is, of course, a condition of low vitality in the tissues, rendering them non-resistant, and it makes no difference in the result whether this condition is inherited or acquired.

**Etiology.**—The exciting causes may be considered under three headings.

**FIRST, PHYSICAL AND CHEMICAL AGENCIES.** These act as causative factors by the destruction of cell-activity and may do so in one of two ways, either by killing the cells outright or by exciting a very acute inflammation in the injured tissue. Under this heading may be placed (a) direct traumatism, crushing out the life of the parts by the force of injury, (b) corrosive chemicals and caustic alkalies, (c) excessive heat or cold.

**SECOND, OBSTRUCTED CIRCULATION.** This obstruction may be either arterial, venous or capillary, and in considering them separately we must not overlook the fact that a diminished cardiac power, while never independently a cause of necrosis, may aid markedly in the production of stasis in any of the vessels. Arterial and venous obstruction result most commonly from rupture, compression, thrombosis or embolism. Some drugs, by causing spasmodic contraction of the arterioles, may cause gangrene. Ergot is the one most commonly cited. Capillary obstruction is nearly always the result of pressure from without, as in tight bandages, faultily padded splints, or prolonged sickness necessitating lying for a long period causing bed sores.

**THIRD, INFLAMMATION.** As has been already seen, inflammation may act as a causative agent in two ways: Either mechanically, by pressure of its exudate and resulting stasis, or by the direct action on the tissues of the micro-organisms and their ptomaines. In most cases met with clinically these two influences are present.

**Symptoms.**—There are many symptoms by which gangrene may be recognized. The most important ones will be mentioned, those which

are present in the majority of cases when the gangrenous area is extensive.

**ANESTHESIA.** Completely necrotic tissues are invariably anesthetic. Pain is sometimes complained of, as is numbness; especially in arterial obstruction. Sudden and sharp pain followed by loss of pulsation in the main artery of a part is always indicative of an embolism. The presence of tenderness in a part, upon gentle pressure, positively excludes necrosis but the manipulation may cause pain in subjacent tissues. The best test is puncture with an aseptic needle.

**ARREST OF CIRCULATION.** This is always complete when death has occurred. If there is no pulsation distinguishable in the main supplying artery, if compression on the proximal side of the main vein causes no dilatation, if compression of the capillaries expels color which fails to return, the condition can be stated positively. Marked feebleness in the capillary circulation in acute inflammations and general atheroma should place the surgeon on his guard against approaching necrosis.

**LOWERED TEMPERATURE.** This is an early symptom when obstructed circulation is at fault, but when acute inflammation is the causative factor coldness is preceded by normal or even elevated temperature, before other well defined symptoms appear.

**DISCOLORATION.** The color of the parts depends upon the cause and whether or not putrefactive changes have developed. When due to arterial obstruction the parts are first pale and bloodless, later becoming shriveled, dry and brownish. When due to capillary or venous obstruction the parts are intensely congested in the early stages, later turning to a blackish or yellowish-green and covered with blebs which contain serum and, if putrefaction has obtained, some gas. The acute inflammatory signs which precede are familiar.

**LINE OF DEMARCATION.** This is the dividing line between the dead and the living tissues. In the infective cases it is the limitation of the spreading; in the aseptic it denotes the extent of the trauma. It is a well marked wall of granulation tissue, beyond which is an area of hyperemia of repair which causes so wide a contrast between the diseased and healthy parts that it alone is diagnostic. The dead tissue is finally separated from its attachments to the healthy by a process of softening, which may be fatty degeneration, if the parts are kept aseptic, but which is usually a suppurative one. In deep tissues it may become encapsulated by the changing of the granulating tissue into a fibrous capsule.

The general symptoms depend upon cause, location and extent, and may be slight or severe. A rapidly fatal termination is not uncommon. They are of the nature usually, of a septic fever, and will receive attention later as septicemia.

**Varieties.**—There are two kinds of gangrene, named exclusively upon the relative proportion of fluid in the dead structures. They are termed dry and moist.

**DRY GANGRENE.** Of this form the really typical expression is termed senile gangrene. It occurs nearly always in old men with a tendency to atheroma and feebly acting hearts. If the patient complains of cold feet; if his boots hurt him; if ever since the occurrence of some trifling injury a few weeks previously he has had almost constant pain; if the toes are blue most of the time, an especially dark color beginning



in a little spot, slowly spreading, the surgeon has a case of senile gangrene to deal with. Left to itself the part shrivels and dries up to the point of obstruction of the artery, and should the patient not die of exhaustion or sepsis the part will drop off at the line of demarcation and the stump heal by granulation. The gangrene accompanying diabetes is similar to this variety, and when dry gangrene occurs in patients not having atheromatous arteries diabetes is always to be thought of.

Frost bite constitutes another form of gangrene which is usually classed as one variety of the dry form, but it may be either dry or moist. From its frequency and special interest it will be considered separately.

The post-mortem changes consist simply of atrophy and desiccation. There are rarely any signs of decomposition. Literally the part is starved to death, and there being no moisture and no heat micro-organisms cannot flourish in the tissues.

*Treatment.* In developed cases there is only one treatment, removal. When threatened the surgeon should use every means in his power to prevent it. Apply electricity, massage and heat locally; correct a failing heart by stimulation; place the patient on the best and most nourishing diet, and if the tendency is still toward local sloughing cut down on the artery, find the point of obstruction and amputate well above it.

**MOIST GANGRENE.** There are a number of clinical varieties but, whether resulting from direct injury, from arterial embolism or rupture of the artery, from venous thrombosis, from inflammatory obstruction and secondary infection, or from primary effects of micro-organisms the appearances are much the same. The parts become swollen and purplish in color, soon changing to a mottled grey-black or green. The cuticle is separated from the true skin by a brownish, bloody fluid, forming blebs and bullæ, which, breaking, leave a raw, moist dermis exposed, from which exudes an ichorous fluid with a peculiar, putrid odor, in itself almost diagnostic. When due to direct injury, the tissues being too much devitalized to react by inflammatory process, the disease is termed primary traumatic gangrene. The disease shows no tendency to involve any but the injured tissues and indicates a circumscribed cause; the tissues about the destroyed area become irritated and hyperemic and their cell proliferation becomes formed into a granulation tissue, separating the diseased from the healthy area. This is the line of demarcation. The diseased area is then thrown off and is termed a sphacelus, or slough. Gangrene of an extremity beginning with sudden and extreme pain is almost invariably due to arterial embolism, and is most frequently seen in patients with endocarditis and in typhoid convalescents.

*Inflammatory or Septic Gangrene.* When, however, the tissues are involved in a process of infective inflammation, when perhaps the injury has been so slight as to have escaped notice, the first symptoms are those of a rapidly spreading local inflammation accompanied by severe constitutional symptoms and it can be counted a case of true inflammatory or septic gangrene. The intense local inflammation spreads quickly toward the trunk, leaving in its wake all the signs of moist gangrene, such tissues usually undergoing very rapid decomposition, if not removed. The general symptoms assume a typhoid character, with hiccough, delirium, coma and death.

*Hospital Gangrene.* Before the introduction of antiseptic methods in

hospital practice the frequency in the occurrence of infective inflammation resulting in formation of sloughs gave us the term hospital gangrene, or sloughing phagedena. In reality it is a rapidly spreading infective inflammation and from the tendency to coagulation-necrosis has been termed wound diphtheritis. The microbe has not yet been discovered and the disease is so rare now that experimental research is limited. Many hold it to be genuine diphtheria.

*Malignant Pustule.* This is a form of gangrene contracted from animals suffering from splenic fever. It is due to the bacillus anthracis, and begins as a pimple at the site of inoculation. This soon changes to a vesicle which in turn merges into a blackish slough and becomes surrounded by a ring of vesicles and around this a ring of redness, induration and edema. It spreads rapidly, constitutional symptoms develop, and unless nature arrests the spread or the proper treatment is instituted systemic toxemia results and the patient is apt to die.

*Treatment.* The treatment of moist gangrene involves two principles: First, prevention, when threatened. Second, limiting the process when it has begun. In the traumatic variety when the process shows evidence of limitation complete removal of the diseased area is the only treatment. There is no need of repeating what has already been so strongly urged in the treatment of infective inflammation. If early incisions and energetic antiseptic treatment are of no avail it is folly to wait for a line of demarcation. Amputation some distance above all signs of inflammation should be performed. The treatment of malignant pustule is similar to that of carbuncle. When very large, incision, curetting and local antiseptic applications constitute the surest therapy. When small, total excision is the proper treatment. Five or ten per cent. solution of carbolic acid injected into the pustule offers fairly good results. The injection should be followed by antiseptic fomentations.

*Frost Bite.* Gangrene from cold does not differ especially from that of other causes. When primary, it is of the dry form; if secondary, as the result of inflammatory process, it is moist. The first effects of cold are stimulating, afterwards sedative. When the exposure is either prolonged or severe the parts pain and tingle and finally become cold and white, they shrivel and never again regain their warmth, and sensation and circulation cease. In other cases where vitality is not completely destroyed the tissues react in an inflammatory process of a low type, resulting in death of the part, or perhaps in a superficial sloughing only. Chilblain, pernio, is a mild form of frost bite, which is aggravated by a too sudden application of warmth.

Its treatment consists in gradual restoration of the circulation. If this be accomplished too suddenly inflammation and sloughing are almost certain to be induced. The part should be submerged in ice water, which should gradually be allowed to rise to the temperature of the cool room in which the patient is placed. With signs of returning vitality rubbing with snow or smooth pieces of ice may be of service. Whatever else is done hurrying should be avoided; for, even with the best that can be done there is always a reaction, which may be very violent and painful, and will be surely if haste be used. Should pain be severe morphine should not be denied. If coma or collapse supervene artificial respiration and stimulation must be continued while the local

treatment is carried on. After recovery the parts are tender and should be protected from all irritation, the patient placed in bed and cold applications continued on the elevated and quiescent tissues. If death of the affected area ensues in spite of all efforts amputation is demanded.

**Practical Hints.**—There are a few practical hints in connection with the subject of necrosis which may be of value. It is never best to operate upon diabetic subjects unless absolutely necessary. Wounds in such patients do not heal kindly, and the slightest infection is apt to lead to gangrene.

Prevention of bedsores from pressure is a very difficult task in prolonged illness. Rubbing to keep the circulation active, and frequent change of position and distribution of pressure when possible, combined with perfect cleanliness, are the best preventives. When formed, antiseptic dressings to prevent infection and due observance of the preventive methods mentioned will answer better than medical applications.

Every patient presenting himself with conditions strongly indicative of commencing gangrene should have the part prepared just as is proper for an operation. This is the greatest safeguard against the addition of the putrefactive to the necrotic disease. In cases of moist gangrene, where the putrefactive process is already present, the constant application of reliable antiseptics may be sufficient to destroy the unpleasant odor and prevent absorption and septic intoxication.

Excision is the best treatment, but when patients object to or absolutely refuse operative measures creolin or chlorine water will act well if the discharges are very offensive.



## CHAPTER X.

### SEPTICEMIA.

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**Types.**—Under this heading will be considered those forms of so termed blood-poisoning which are unattended by the formation of metastatic or secondary abscesses. Of these there are two distinct types: sapremia, or septic intoxication, and progressive septicemia, or septic infection. Clinically they are often indistinguishable and no doubt at times occur simultaneously.

**Sapremia.**—This is a term given to a form of blood-poisoning due to the introduction into the system of the chemical products of putrefaction, the ptomaines being developed by saprophytes in the destruction of organic matter. Such bacteria are not in the true sense pathogenic and develop only in dead tissues. They are thus found developing frequently in the human body where true infective processes have destroyed a certain amount of tissue, such as gangrene, large pus collections or inflamed wounds. An imperfectly drained wound, an imperfectly cleaned uterus after miscarriage or child birth, or a retained blood clot in a natural or artificial cavity may be the seat of putrefactive germs and hence of septic intoxication. The poison is of a chemical nature. The severity and rapidity of the symptoms depend largely upon the amount of the poison absorbed and soon subside upon the prevention of further absorption.

**SYMPTOMS OF SEPTIC INTOXICATION.** They are usually ushered in by a chill soon after absorption commences. The temperature rises rapidly, often reaching 103 degrees or 104 degrees F., in a few hours. With the high fever headache and nocturnal delirium usually are prominent symptoms and, if the absorption continues, are followed soon by nausea, vomiting, and diarrhea. The pulse is usually rapid and compressible, showing, first, a lowered arterial resistance and, later on, degeneration of the heart muscles. If the amount of absorption be large, or if the supplying focus be not removed, the delirium may change to coma, the temperature fall to subnormal and the patient die suddenly with all the symptoms of collapse. More commonly, however, the progress is slower, the patient becomes weak and anemic from the constant drain of the vomiting and diarrhea which supervene, and death occurs from exhaustion.

**DIAGNOSIS.** Septic intoxication must be separated from septic infection and from that fever which has been described as traumatic. In the latter the onset is sudden, always beginning a few hours after the injury or operation, with infrequency of sick feelings, save perhaps a slight headache and restlessness, and tendency to spontaneous subsidence in a day or two. From true septicemia it is more difficult, often impossible, to diagnose it for, as already intimated, they are often combined. If it be remembered that there must be dead tissue some place, that this tissue must have been exposed to atmospheric influences to become the

seat of putrefactive changes, and that these putrefactive changes are nearly always accompanied by the odor of decomposition it can usually be determined satisfactorily whether or not we have to deal with sapremia or septicemia. If, after discovering a focus of putrefactive absorption and removing it the symptoms continue true septicemia complicates the sapremia, beyond question.

**PATHOLOGY.** The chief post-mortem changes are extensive disorganization of red blood corpuscles and congestion of nerve centers and abdominal viscera. The kidneys and intestinal mucous membrane suffer most because of the fact that they are the active agents in eliminating the poison. The rapidity with which the extreme cases prove fatal accounts for the slight destruction of tissues and consequent absence of gross lesions.

**PROGNOSIS.** This, of course, depends upon the stage at which the patient applies for treatment and the accessibility of the focus to correct surgical treatment. Uncomplicated cases, seen early, usually recover.

**TREATMENT.** The removal of the cause is all sufficient. The whole treatment can be summed up in the single word, cleanliness. The cause may be found in an imperfectly drained wound or abscess, the discharge being allowed to collect and decompose. It may be found in the shape of a blood clot, a piece of retained placenta, or in the products of the action of other bacteria. Whatever the cause is found to be it must be removed if possible. Antiseptic cleanliness, free and adequate drainage, and protection from secondary infection by antiseptic dressings will constitute the local measures; nourishing diet and plenty of it, fresh air and stimulants, if the heart seems to require them, the general ones. If the removal of dead tissues is impractical their neutralization by iodoform or carbolic acid is the best measure.

**Progressive Septicemia, or Septic Infection.**—The difference here is the same as has been described in treating of septic and infective inflammations, the difference between a chemical and a specific poison, the difference between dead tissues and living tissues. In progressive septicemia we have to deal with pathogenic bacteria; bacteria capable of multiplying, not only in the tissues at the site of inoculation but which find their way into the blood and, in the later stages, develop there; bacteria which produce toxic substances, both in the blood and in the tissues, giving rise to the most serious symptoms through their absorption. The presence of a small wound accompanied by severe constitutional symptoms should always make the surgeon suspicious of progressive septicemia.

**CAUSE.** There have been some enthusiastic bacteriologists who claim to have discovered the specific microbe of septicemia, but it is now tolerably certain that most cases met with clinically are produced by the microbes of suppuration. Just why these microbes should produce suppuration in one case, septicemia in another and pyemia in another cannot be positively explained at the present time. It has been definitely settled experimentally in animals that if large quantities of pus microbes be injected into the tissues death will result from progressive septicemia before one drop of pus has been formed. Most surgeons of experience have had fatal cases which could be explained only in this way, especially in accidental wounds involving the peritoneum.

There can be little doubt that some of the micro-organisms enter the circulation in every case of suppuration, only to be destroyed in the blood by the blood plasma and white corpuscles or to be carried away by the organs of elimination.

Suppose, however, a patient weakened by disease and large quantities of microbes in such weakened tissues with everything suitable to rapid development, the ptomaines produced by their rapid multiplication still further lessen the vitality of the patient and reduce still more the quality of the blood until it has no longer the power to resist and destroy the bacteria. Then, given bacteria both in tissues and blood, multiplying in both places, and giving rise to their toxic substances, there is presented a clear case of septic infection.

**SYMPTOMS.** There is always a period of incubation during which the micro-organisms are developing before symptoms of any seriousness appear. This is usually not less than twenty-four hours and may be four or five days.

As in most acute diseases, the attack is ushered in by a chill or by a sensation of coldness; this may be repeated from time to time, but usually not, and is never so periodical as in pyemia. The increase in the temperature is generally gradual and this is about the only symptom which differs from sapremia.

There is the headache, backache and sleeplessness; and indifference, not only to his own condition but to everything about him, is very frequently observed. Nausea, vomiting and diarrhea may supervene, the patient becoming very rapidly emaciated. The mental symptoms may be a continuation of this kind of stupor, or active delirium set in. In fact the whole disease reminds forcibly of the toxemia observed in typhoid fever.

The tongue is always coated, in the worst cases becoming very dry and brown, often cracked. The temperature usually runs very high, 104 degrees to 105 degrees, or even 106 degrees, with a slight morning remission. In other cases the depression is very great and the temperature may even be subnormal in fatal cases of septicemia. A rapid pulse, 130 to 140, giving the sensation of vessels only partly filled is particularly suggestive of a fatal termination, if occurring with low temperature.

**DIAGNOSIS.** The differences between this and septic intoxication have already been discussed. From typhoid fever the history of the case, the eruption and the absence of an infectionarium must be the guide. Septicemia will be differentiated from pyemia in dealing with the latter disease.

In cases presenting a line of symptoms such as have been described it is not well to make a hasty diagnosis of intermittent, remittent or typhoid fever. The possibility of a suppurative fever should not be forgotten, even when there is no external focus of suppuration.

**PROGNOSIS.** The prognosis is always grave. A fully developed case of septicemia is invariably fatal. In the initial stages, if the infectionarium is in a locality favorable to surgical cleanliness and disinfection the surgeon may promise a little hope, but the tendency is to an increase in severity of the symptoms and death of the patient.



**PATHOLOGY AND MORBID ANATOMY.** The post-mortem changes are those of sapremia a little further advanced. The blood is disorganized, the destruction of red corpuscles very marked. In the lining membrane of small arteries, veins and capillaries are found numerous spots of tissue-softening and inflammation, which serve as secondary foci for germ development and multiplication. The congestion of internal organs becomes inflammation and may attack any of the viscera, the kidneys, lungs and intestines suffering most frequently. Albuminuria is always present in severe cases. The weakening of blood-vessels and the fluidity of the blood favor hemorrhagic transudations, and nearly all of the serous fluids are blood stained. Mucous and serous membranes and sometimes the skin even will be found dotted with ecchymotic spots. Endocarditis is also a frequent complication. The micro-organisms, most often those of suppuration, are found not only in the tissues but in the blood. Inoculation of animals with the blood of septicemic patients frequently proves fatal. In rapidly fatal cases these changes have not had time to occur and there will be a peculiar absence of gross lesions, which is characteristic of the disease.

**TREATMENT.** It seems hardly necessary to speak of the prophylactic treatment of this disease. Nor is it necessary to dwell longer upon the importance of aseptic and antiseptic measures even in the smallest wounds. Early and energetic treatment of the infected area before the micro-organisms become too numerous is imperative. Whether the wound be operative or accidental, free and adequate drainage should be supplied, even if the removal of all stitches is necessary to attain it. The lips of the wound must be separated throughout so as to bring sterilizing solutions into direct contact with every crevice. The wound should then be loosely packed with gauze and antiseptic compresses applied. When the inflammation has subsided and the granulations are healthy secondary suture may be used to hasten the healing process.

Natural cavities, when involved, should be just as energetically drained. In peritonitis the abdomen must be opened, not only the suprapubic incision, but by counter incisions in both lumbar regions. Irrigation with a solution of common salt or boracic acid followed by large iodoform gauze drains in each of the three incisions will give the best chances of reaction. Other cavities, such as the pleura and the different joints, must be treated on the same general principles.

If the symptoms accompany a diffuse suppuration or gangrene the treatment recommended under those headings should be carefully followed. Stimulation, nourishment, fresh air and cleanliness in connection with the medical treatment that will be mentioned under pyemia will serve best.

Pasteur asserts that immunity from septicemia can be gained by inoculation with an alkaloid termed sepsin, which Bergmann has separated from the tissues of animals suffering from septicemia. The fact has been proved beyond question in animals, mice being the objects of experimentation with the French scientists. Whether the same treatment will apply to man remains to be seen. In the meantime, "prevention above cure."

## CHAPTER XI.

### PYEMIA.

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**Nature.**—Pyemia is regarded by many authors as a later development of progressive septicemia, the clinical differences being ascribed to the longer duration and the less active progress, giving time for the suppurative changes to take place.

**Etiology.**—This is another form of blood-poisoning due to the action of pyogenic micro-organisms, though the reason is not plain why those germs should produce septicemia in one case and pyemia in another. The most satisfactory explanation is in the method of their introduction into the general circulation. For instance, in septicemia they enter in large quantities in their free form and the condition of the blood not being such as to determine their destruction they multiply therein, giving rise in their development to the ptomaines productive of the systemic symptoms. This intra-vascular development, as post-mortem appearances indicate, takes place in small foci in the walls of the smaller arteries and veins where the microbes have become localized. There is little reason to doubt that if the patient lived long enough these foci of inflammation would progress and cause the formation of infective thrombi and thus result in typical pyemia.

It is the formation of infective thrombi through involvement of veins and capillaries in suppurative inflammations that gives its characteristics to pyemia. By a softening of a thrombus the microbes are carried into the general circulation in the form of particles of coagulated blood, and becoming arrested in other parts serve as a focus of development of new areas of suppuration. Thus the causative difference, in so far as is known, is that in septicemia the germs enter as free micro-organisms, in pyemia as infected emboli.

The clinical difference is that pyemia has the secondary or metastatic abscesses. It is claimed also that these secondary abscesses may result from traumatism and localization of free floating germs. The disease is not, according to latest observers, due to any special microbe, but may be caused by any of the varieties of pus microbes described.

The clinical varieties of pyemia are the acute and the chronic. They differ in degree rather than in kind.

**Pathology.**—The presence of secondary abscess and the frequent jaundiced condition is all that is worthy of note in addition to the congestion of the viscera, nerve centers and serous membranes, and the disintegration of the red blood corpuscles which is found in septicemia. Pus microbes are invariably found in the blood and in the secondary abscesses. These secondary abscesses are most frequently found in the lungs and liver, as they are the first organs to receive the venous blood.

**Symptoms.**—In acute pyemia, chill, high fever and profuse sweating frequently repeated are the main symptoms. The suddenness of the changes is the characteristic of the disease if it has one, the tem-

perature varying from two to five degrees in a few hours. The pulse is rapid, the tongue red and glazed and, later, dry and brown, the emaciation is marked and rapid, the countenance becoming drawn, anxious and jaundiced. The patient soon assumes the typhoid characteristics, the discharges becoming involuntary and frequent, the urine albuminous. There is said to be a peculiar sweet odor to the breath and other exhalations which is considered by some as a strong diagnostic symptom. The secondary abscesses usually form after the first week, and the additional symptoms depend somewhat upon their location. In the chronic form the symptoms are less marked. The tendency is to suppuration of the synovial membranes or other serous cavities. This is not due to emboli but to localization of circulating germs in tissues of low vitality. The patient may recover after months of careful treatment or die from exhaustion.

**Treatment.**—A well developed case of acute pyemia is incurable, but under antiseptic measures well developed cases seldom occur at the present time. Proper treatment of a primary suppurative focus in the beginning invariably aborts the general disease. When secondary abscesses form early opening and drainage is the only treatment to pursue. In addition to the surgical treatment of the wound and of forming abscesses, and an abundance of fresh air and nourishing diet, certain remedial agents are recommended both for septicemia and pyemia. Alcohol is among the most reliable agents, its benefits occurring from its stimulating and antidotal effects. It must be remembered that the disease is a poison and should be treated as such. Alcohol must be given freely, best in the form of punch or eggnog, and at frequent intervals; the quantity must be suited to the patient, the size of the dose regulated by its action and not by preconceived notions. Patients take enormous quantities of alcoholic stimulants without injurious effects in these septic diseases. Phenic acid was formerly used, either internally or by hypodermic injection. It was supposed to exert a direct antidotal influence and be a most reliable medicine. But it has now generally fallen into disuse and is no longer recommended in this connection. Quinine is also falling into disuse in this disease and little is claimed for it save as a stimulant and antipyretic. After the poison is eliminated the extreme prostration is best combated by such remedies as arsenicum, china, the arsenate of china, muriatic acid and the snake poisons. In the mild forms of septic intoxication sulpho-carbolate of soda is considered almost specific. In convalescence the importance of diet should not be forgotten. Nutrition will be increased by gentle massage or electricity, and inunctions of olive oil are sometimes very effectual.

**HECTIC FEVER.** A form of suppurative fever accompanying chronic inflammation is called hectic fever. It is a chronic form of sapremia. There is no tendency to formation of metastatic abscesses. Its very slow progress may be accounted for in the fact that absorption being slow the system becomes in a measure proof against its virulence. It occurs most frequently in internal suppuration, the retained discharges undergoing decomposition and absorption. It is exceedingly fatal if the cause cannot be removed, death resulting from progressive emaciation and exhaustion. The regularity of the chills, fever and sweat may cause the error so frequently made of calling the disease "malaria." The history will



usually clear up all doubt. The removal of the causes by perfect cleanliness and drainage, where these are practicable, and the treatment above noticed are necessary to effect a cure.

Skill in curing such febrile complications should be commended, but the surgeon should be esteemed more worthy in preventing them. The strongest argument that can be brought to the support of surgical cleanliness is the infrequency of these diseases under its reign.

## CHAPTER XII.

### TETANUS.

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**Nature.**—Tetanus is a disease characterized by intense spasms of the voluntary muscles which in the intervals maintain a condition of tonic rigidity.

**Etiology.**—In the light of recent investigations tetanus can no longer be regarded as a complication of nerve injury. The fact that it occurred both as a result of injury and irrespective of such gave origin to a division into traumatic and spontaneous tetanus. Such classification is unnecessary, for the disease, whether acute or chronic, is an infective malady, invariably produced by the introduction into the system of the bacillus tetanus. This micro-organism and its characteristics have already been considered. The infection usually arises in connection with a wound, though the germs may gain entrance into the circulation through the mucous membranes of the respiratory or alimentary tracts.

**Pathology and Symptoms.**—It has been stated that the bacillus tetanus acts only in conjunction with the pyogenic microbes. Without making such an assertion it is a clinical fact that the few cases that have come under the author's observation have been in connection with infected wounds. During the early manifestations of tetanus the multiplication of germs is limited to the point of inoculation. Indeed, recent investigators assert that only in a small percentage of cases, even in the late stages, are the microbes found diffused throughout the tissues. The post-mortem appearances reveal nothing as to the mode of action. That the action is exerted especially upon the spinal cord and the medulla is certain, but the changes noted in these structures have not been constant. Bowlby says that in all the cords examined by him he found nothing but typically normal tissues.

The symptoms are not due to the direct action of the microbes but depend upon the toxins generated by them. They may be illustrated by the following typical case: J. R., age ten years. Had two fingers almost cut off by a hay mower. After the wounds were dressed he suffered no inconvenience and repair was apparently progressing nicely. Fifteen days after the injury he began to complain of stiffness in his neck and jaws. The next day he began to walk stiff-legged and could scarcely open his mouth. By the eighteenth day it was impossible to bend his body or his legs, the only muscles that were not perfectly rigid being those of his arms and they were partially so. Patient entered the hospital on the twentieth day. His consciousness and intellect were unimpaired; temperature 100.6 degrees, pulse 124, respiration 36. His back was arched (opisthotonos), the abdomen flat, the legs and feet fully extended and so rigid that they could not be moved, the jaws so firmly closed that it was impossible to wedge even a case knife between the teeth. The corners of the mouth were retracted, giving rise to the characteristic risus sardonicus; clonic convulsions were occurring every few

minutes and the respiration would at times seem almost completely suspended owing to spasm of the respiratory muscles. The symptoms continued about in this way for ten days, the temperature ranging between 99 and 105 degrees and the pulse from 112 to 150, the respiration from practical suspension to 48 per minute. The spasms after the first day or two were typical, the condition of opisthotonos being especially marked. After the eleventh day the spasms ceased, the patient lying for a few more days in tonic rigidity and then gradually regaining muscular control.

This case is typical of the acute form; the chronic form differs only in severity and degree. The period of incubation varies from a few days to a few weeks and the distortion depends upon the group of muscles most strongly affected. Respiration is always hurried and difficult, the pulse rapid, the skin pale and usually bathed in profuse perspiration; a slight elevation of temperature is the rule, but great height of fever may be attained and very suddenly. In mild forms when the muscles of mastication only are involved the disease is termed trismus. All cases of trismus, however, are not necessarily due to the action of the bacillus tetanus.

**Prognosis.**—Gowers estimates the death rate of acute tetanus at ninety per cent. Most of the deaths occur during the first week from one of four causes: (a) spasm of the glottis; (b) spasm of the respiratory muscles; (c) syncope; (d) exhaustion. The disease seems self-limited. Miner asserts that those cases that can be kept alive for two weeks usually recover.

**Treatment.**—From the exceedingly great mortality it may be surmised that the treatment of acute cases is not very satisfactory. It has been said that the two qualities of a healthy nervous system are: First, to act, and second, to rest. The ability to rest in tetanus is lost. That we cannot destroy the poison of tetanus, after it invades the human system, is pretty generally acknowledged, so the factors to be aimed at in treatment are well pointed out by a recent English writer: First, prevention of further development. Second, elimination of the toxic products. Third, the sedation of the nervous system. Excision, cauterization or chemical sterilization of the infected area is the first duty. Ability to eliminate the toxic matter is questionable and too much reliance must not be placed upon diuretics, diaphoretics and cathartics on account of their depressing effects. After the prevention of further development the sheet anchor is sedation. Let it be remembered that the cord and medulla are under the influence of a strong poison; that against such influence ordinary therapeutic doses have little or no effect; that the greatest danger lies in the prolongation and frequent recurrence of the paroxysms. The surgeon's object is to prolong the remissions, to modify if he cannot prevent the convulsions, and to antidote the influence upon the nerve centers so that the patient can rest. The agents from which the best results are claimed in old-school practice are: Chloral-hydrate, the bromides, morphine, calabar bean and strychnia. Chloroform is of marked value during the severe spasms and especially when the patient has been neglected until the disease has made good progress. It should be pushed to the stage of complete narcosis and the patient so held until the other remedies given by hypodermic injection or rectal enema, during anesthesia, have had time to take effect. This, as a rule will not be longer than from



fifteen to thirty minutes. Chloroform is then suspended and the patient passes from the control of one agent to that of the other, the doses to be repeated or enlarged according to circumstances.

The treatment in the successful case cited was as follows: Amputation of the fingers under the strictest antiseptic measures; ice bags to head and spine; absolute quiet in a darkened room; the lightest and most easily digested food (liquid), and the following remedial agents: Gelsemium, potassium bromide, chloral-hydrate. These were followed by lobelia. Chloroform was administered during the spasms. When the patient began to vomit the lobelia was discontinued. This remedy was followed by physostigma, the dose depending upon the severity of the spasms.

## CHAPTER XIII. HYDROPHOBIA.

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**General Considerations.**—Hydrophobia is defined as a nervous disease due to inoculation with specific poison. The bites of animals are among the most distressing forms of wounds, not only on account of the contusion but also from the nervous condition brought about by fear. The belief among the laity that all patients bitten by rabid animals will develop hydrophobia should be corrected, the fear of this disease being very distressing. While it is true that the bites of rabid animals upon an exposed part of the body are almost uniformly followed by constitutional symptoms those inflicted through the clothing are not in more than twenty per cent. of the cases. This is owing to the fact that the poison is introduced through the medium of the saliva, most or all of which is absorbed by the clothing before the teeth reach the integument. The treatment of such bites is similar to that of snake bites. Strangulation of the tissues above the injury to prevent absorption; preparation of the surrounding area as for any antiseptic operation; total excision of the area if it be small and not too disfiguring; or if that be impracticable free incision through each tooth mark clear to its utmost depths and irrigation of the wounds thus made with a strong mercuric solution, while with the finger the poisonous matter be thoroughly washed away. In the latter form of treatment the wound had better be cauterized, either with the actual cautery or with pure carbolic acid, and then packed with iodo-formized gauze to prevent too ready union.

**Causes.**—That it is a microbic disease is beyond question, though as yet efforts to discover the peculiar microbe have proved unsuccessful. If it were due to pre-formed ptomaines in the abnormal saliva of the dog there would be no stage of incubation. Only a living poison can reproduce itself in the living body after its inoculation.

The average period of incubation is from six weeks to three months and is supposed to be due to the slow growth of the microbes.

**Symptoms.**—For a few days prior to the actual development of the disease there is said to be a sensation of tingling or itching in the old wound; the sensations are also felt along the nerves of the part. Small vesicles sometimes appear over the old cicatrix and the neighboring lymphatic glands become enlarged and painful. The first characteristic symptom of hydrophobia in man is a sense of constriction and choking about the pharynx, attended with difficulty in swallowing. This difficulty rapidly increases until the attempt to swallow produces extremely painful spasms. The next group of muscles to become involved is the laryngeal, so that the respiration becomes labored and spasmodic. There is commonly a collection of very tenacious mucus in the pharynx, and the salivary secretion is markedly increased so as to occasion frequent spitting or even driveling. The temperature is always increased, usually registering from 101 degrees to 103 degrees F., but it may become very high.

There is usually a fearful expression of anxiety and no amount of assurance will be able to dispel the fear of impending death. Hallucinations of various kinds may be present, but the usual notion that people bark like a dog is erroneous, that symptom being of or belonging to the hysterical form of the disease. Death usually occurs from exhaustion, spasm of the glottis or spasm of the respiratory muscles about the third or fourth day, though it may be delayed longer.

**Diagnosis.**—It is diagnosed from tetanus by the intermittent character of the spasms, the hallucinations, the long stage of incubation, the laryngeal spasm as opposed to the intense trismus, the increased saliva and the history of a bite of a rabid animal.

**Pathology.**—Beyond a congested appearance of the brain and spinal cord the naked eye gives us no clue to the morbid anatomy. The microscope, however, reveals some especially interesting features about the medulla oblongata. These consist of an infiltration of leucocytes into the vessel sheaths, showing that the vessel walls themselves have undergone changes. These same inflammatory changes give rise to thrombosis in some of the smaller veins, and secondary softening of nerve cells takes place. If of longer duration no doubt the changes would soon be perceptible to the naked eye.

**Treatment.**—As the disease is invariably fatal when once it has developed treatment may be divided into prophylactic and palliative. In prophylactic treatment attention to the wound is of the utmost importance. Early excision, cautery and powerful antiseptics in these cases must not be forgotten, excision and disinfection being the simplest and best. Another form of prophylaxis is by inoculation with the virus of hydrophobia. It is to Pasteur that we owe this important method.

Pasteur's experiments which led up to this discovery may be briefly stated thus: Inoculations of the virus of hydrophobia in animals invariably produced the typical disease after a period of incubation. The period of incubation is shortened as the virus is passed from one animal to another, showing conclusively an increase in the virulence of the poison. If the spinal cords of animals dead of hydrophobia artificially produced be preserved in perfectly pure dry air from seven to eight days the virulence is entirely destroyed and inoculations are harmless. Now by using virus of different strengths, carefully graded by virtue of the length of time it was exposed to the air, beginning with the weak and gradually increasing the strength of the preparation, Pasteur rendered animals immune to the action of the most potent inoculation material. The success of these experiments led to the trial of a method in man and the results must convince the most skeptical of its utility; for even in cases bitten by animals determined by experiment to be rabid the mortality has been reduced to less than one per cent. The earlier after the injury the treatment is begun the better the hopes of prevention, and such cases should at once be sent to the nearest Pasteur Institute.

**PALLIATIVE TREATMENT.** This consists of perfect quiet and darkness. The patient should be kept ignorant of the nature of his ailment if possible, to save mental suffering. Thirst may be assuaged by rectal enemas and all medicines should be given either by rectum, hypodermically or by inhalation. Chloral, the bromides or morphine may be inserted as steady medication, giving inhalations of chloroform during the spasms. The disease is usually fatal.







*Geo. F. Hardlaw, M.D.*

PLATE I

*Fig. 1.* LYMPH NODE. TUBERCULOSIS. -  $\times 40$

*Fig. 2* APPENDICITIS. -  $\times 75$ .

HARDED IN ALCOHOL. STAINED WITH HAEMATOXYLIN AND EOSIN. AND MOUNTED IN CANADA BALSAM.

## SECTION II.

# LABORATORY TECHNIQUE.

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## CHAPTER I.

### PRELIMINARY DETAILS.

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**Prefatory Considerations.**—There are certain branches of microscopic diagnosis that are of great practical use to the surgeon, as the diagnosis of tubercular, inflammatory and tumor tissue. Fortunately, these subjects are not especially difficult of apprehension, and may be learned by an energetic student from plates and descriptions, together with such common surgical material as may come into his hands. Yet a personal knowledge of microscopic and bacteriological research as obtained in the laboratory is invaluable to the surgeon.

**Furnishings of the Laboratory.**—The pathologist should have a place set apart for use as a laboratory. If a whole room can be devoted to this purpose, so much the better. If this is not possible, one corner of the office, containing a wooden table and shut off by a screen, will suffice. There should be a spot devoted to pathological research that is not liable to disturbance by anyone except the surgeon and his assistants. To this spot should be brought all pathological material as soon as it is received; and here the investigator should have a sharp knife, scissors, corked bottles, preserving fluid, staining materials, microscope, slides and cover-glasses, test-tubes and a lamp ready for immediate use.

**LIGHT.** (*a*) For microscopic work, as well as for gross examination, daylight is by far superior. It is best obtained by a large window facing north. All gross material should be examined in daylight. In using the microscope it will be found that the light from a bright white sky or a white cloud is better than that from the blue sky. Direct sunlight should be avoided; it injures the mirror and lenses.

(*b*) An incandescent electric light is the light next best to daylight; it is serviceable at any time of the day or night. One of the lights should be quite near the microscope.

(*c*) Lamp-light, especially the light of a student-lamp or of any good oil-lamp, comes next in preference.

(*d*) Gas-light should be taken from a globular lamp-shade. When the mirror of the microscope reflects the edge of the flame or the light of a narrow shade it illuminates only a narrow streak through the center of the field.



FURNITURE. The laboratory should contain, if possible:

(a) Running hot and cold water, and a sink. This may be partially improvised by a keg placed on a low shelf, with a basin or bucket beneath.

(b) A table or broad low shelf, near the sink, on which gross material, especially large tumors and autopsy material, may be dissected and examined. The table may have a marble, slate or wooden top. A wooden top is to be preferred as it does not blunt the knife in dissecting. Under or upon this table should stand large jars or bottles of preserving fluids, ninety-six per cent. alcohol, Mueller's fluid and a ten per cent. watery solution of chromic acid. On this table, or near it, should stand the bottles and jars containing gross material which may be needed for further examination or be preserved as gross specimens; four-ounce and half-ounce bottles in which tissue is being hardened and embedded; empty two-ounce and half-ounce bottles, corked, ready for the preservation of new material; and specimens of urine, which should be kept apart from other material.

(c) A firm table, three feet square or thereabouts, upon which rest the microscope and the staining outfit. The table should be placed so that the observer faces the light; or, less preferably, with the light at his right or left hand, but never at the back. The microscope should have a definite place on the table, from which it should seldom be moved.

(d) If the pathologist enjoys the luxury of a microtome this should be fastened upon a separate smaller table on which should be placed, also, a covered dish containing the blocks of specimens which have been or are to be cut.

(e) A table for writing materials, on which is kept the Laboratory Record Book and stationery.

(f) A Bunsen burner attached to a gas-pipe, or an alcohol lamp.

APPARATUS. *The Microscope.* A good microscope for ordinary pathological work consists of a firm stand, with tube, draw-tube and broad mirror; a fine adjustment; a double nose-piece; two good objectives, one giving, with the usual eye-piece, a magnifying power of from forty to one hundred diameters, and the other magnifying from three hundred to five hundred, and two eye-pieces, a one-inch and a two-inch. A one-inch eye-piece is sufficient in ordinary examinations. Two eye-pieces, however, will give a wider range of magnifying power, which is very serviceable in drawing. Sometimes the features of a tumor are better presented by a magnifying power of two hundred than by one of four hundred diameters, and vice versa.

If the microscopist enters the field of bacteriology it will be necessary for him to add to his microscopic outfit a one-twelfth oil immersion lens and an Abbe condenser.

Stands, objectives, eye-pieces, etc., equal to those of the best European make, may be obtained from the best American manufacturers. Good lenses and poor lenses are made in several countries, in Germany as well as in America.

One of the best works on the construction and use of the microscope is "The Manipulation of the Microscope," by Edward Bausch. Other books to be recommended are "How to Work with the Microscope," by Beale, and "The Microscope and Microscopical Technology," by Frey.

In addition to the advice given in these works the author will add the following recommendations: The simpler the instrument the more satisfactory will it prove to the manipulator; mechanical stages and complicated mechanisms of all kinds are useless for routine laboratory work; work with the diaphragm open to its fullest capacity; if the orifice of the diaphragm is much below the level of the stage remove it and work without it; use the concave side of the mirror and manipulate it in different directions until the light is clear and white; if the microscope does not give good views consult some competent person before condemning the instrument. A microscope coming from a reliable firm is less apt to be defective than is the manipulative ability of the amateur.

*Microtome.* Every surgical microscopist should have a microtome, that is, a mechanical device for cutting solid tissues in thin slices for microscopic examination. Practical men now regard this instrument as a necessity. The simplest microtome is the Rutherford freezing microtome, or a modification thereof, in which the block of tissue is surrounded by a gum solution and frozen by a mixture of ice and salt. These are pictured and described in Queen & Company's catalogue. This microtome is not adapted to prepare celloidin specimens, which require a clamp to hold the block on which the specimen rests. A simple microtome with a clamp for this purpose is sold by the Bausch & Lomb Co. A razor, the under side of which is flat, or the ordinary microtome knife, is used.

Where it is necessary to cut many sections, as in class work, a larger instrument is required. The Bausch & Lomb, the Schanze and the Thoma are all good instruments, it being observed that in the larger and heavier instruments the knife runs more evenly and cuts more uniform sections. These instruments are quite expensive and are not really required for private work. An excellent microtome has been made by Joseph Zentmayer, of Philadelphia, after the designs of Prof. Ryder.

For freezing and cutting a tissue, if the simple ice and salt microtome is not used, a freezing apparatus may be attached to any microtome which has a clamp for holding blocks.

Nearly all the catalogues picture the freezing apparatus with which the ether or rhigolene spray is used. Bausch & Lomb sell a freezer that uses carbonic acid gas. It is cleanly and rapid in action.

**ACCESSORIES.** For hardening and preserving gross material there are required six glass or earthenware quart preserve-jars, with hermetically sealing covers; six pint-jars, for the same purpose; two one-gallon jars, bottles or cans, one for ninety-six per cent. alcohol, the other for Mueller's fluid, which should be kept in large quantities, and one quart-jar for a ten per cent. solution of chromic acid.

For the preparation of specimens for the microscope there should be six wide-mouthed glass bottles, corked, of four-ounce capacity, for alcohol hardening; twelve wide-mouthed glass bottles, corked, of one-half ounce capacity, for alcohol and ether, and for celloidin; one large glass dish, with cover, for keeping specimens after mounting on blocks—a porcelain or earthenware dish with a closely fitting cover will suffice; six glass salt-cellars, which are more steady than watch-glasses, for staining fluids; two half-ounce glass cups, with covers, for alcohol and for xylol or bergamot; one large glass dish or soup-plate for washing sections in water; two pipettes, for taking a drop of sediment from a bottle; one

gross glass-slides one by three inches; one-ounce glass-covers, either round or square, No. 2, three-fourths inches; one half-ounce ditto seven-eighths inches; one half-ounce ditto, "extra thin," three-fourths inches, for use with immersion lenses; the usual outfit for urinalysis.

Two needles, set in wooden handles (teasing needles) and a copper section-lifter.

A razor with flat blade, a scalpel, dissecting forceps and sharp-pointed scissors.

Bunsen burner or alcohol lamp.

One dozen blocks of wood, one by one by one and one-half inches, for mounting celloidin preparations for cutting.

Absorbent paper (not filtering paper).

One hundred microscopic slide labels and one hundred gummed labels for jars and bottles.

**ALCOHOL.** For dehydrating tissue for microscopic examination commercial alcohol will not suffice. The so-called "absolute alcohol," which is ninety-six per cent. of strength, should be used. The expense may be materially reduced by taking advantage of the revenue provision which imposes no duty on alcohol that is used for laboratory purposes.

With a little care in changing the fluid frequently Mueller's fluid may be used instead of alcohol for the preservation of gross material; though, of course, for museum preparations alcohol is essential.

**MUELLER'S FLUID.** One gallon, or, better, five gallons of this fluid, should be ready for immediate use. It is made by dissolving one part of sulphate of soda and two parts of powdered bichromate of potash in one hundred parts of water. Hot water will make the solution more rapidly.

Gross specimens should be deeply incised to admit the Mueller fluid to all parts of the tissue, and then immersed in a quantity of fluid twenty times the bulk of the specimen. In half an hour the fluid will be very turbid, when it must be renewed. In twenty-four hours it should be again renewed and every day thereafter until it no longer becomes turbid. It then requires renewing only once a week for several weeks and, finally, once a month. In this fluid the tissue will be preserved perfectly, it will not over-harden, as in alcohol, and it is always ready for microscopic examination.

**CHROMIC ACID.** One quart of a standard ten per cent. solution of chromic acid crystals in water should be prepared. When required it is further diluted with water to make a 1-200 or 1-400 solution.

**Examination of Gross Material.**—When a specimen comes into the laboratory the first step is to describe its gross appearances in the following order:

(a) If possible, the part of the body from which the specimen has been taken and the variety of tissue of which it seems to be composed.

(b) Shape and measurements of the specimen in inches or centimeters.

(c) Consistency, color of the exterior and of the cut surface, presence of skin, mucous membrane, ulcers, abscesses, hemorrhages, cysts and calcareous masses or bone.

(d) If the specimen is a new growth describe its margin, whether or not encapsulated; and, above all, whether the line of incision seems to



have gone through tumor tissue, indicating that some of the tumor tissue remains in the body.

These observations should be noted in the Laboratory Book as soon as observed, and should not be left to the uncertainty of future entry. After careful examination of the external appearance the knife should be used liberally; Fallopian tubes should be slit with the scissors, ovarian cysts opened, enlarged glands cut in three or four slices, and sections made through a tumor to disclose the junction of the tumor and healthy tissue; tumors attached to bones, as in amputations, should be cut and sawn through longitudinally, and every care should be taken that nothing of interest which is visible to the naked eye shall escape observation.

**RECORD BOOK.** These items should be noted in a Laboratory Record Book, which should be kept in every laboratory. The peculiarities of a specimen are easily forgotten, and written records are frequently of value. Eight by twelve inches is a convenient size for the book. It should be leather or canvas-covered, to withstand the occasional sloppiness of the laboratory tables. One page is to be devoted to each specimen. The specimens of tumors, urine, sputum or pus, should be numbered consecutively as they are received, and the number placed at the top of the page. Next should come the date when the specimen was received, the surgeon to whom the report is to be made, and under the heading "History" such items of clinical and personal history as are usually sent with the material. Next come the gross appearances; and then the microscopic description, with the diagnosis and, if desired, the prognosis. It is well to add, also, the date when the report was made to the surgeon.

## CHAPTER II.

### USUAL PREPARATION OF TISSUES.

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**Preliminary Considerations.**—Having noted the gross appearances of the pathological material the next step is to prepare it for microscopical examination. Scrapings or teasings may be examined while fresh, but examinations of sections of fresh material are usually unsatisfactory, because the details of the tissue elements cannot often be discerned. For this reason it is customary to pass the tissue through various processes, to be described, which render it more amenable to microscopic study. This preparation may take one of two forms: First, that resulting in stained sections; second, that resulting in unstained sections. In routine laboratory work the material is invariably stained. Unstained specimens are of value for more minute study than is usually devoted to this material, but they are of little practical value in ordinary surgical diagnosis. Stained sections are commonly much simpler and more easy to diagnose than the unstained; and for this reason proficiency in diagnosis is much more rapidly obtained by the use of the stains. In stained specimens, as may be seen by reference to the accompanying plate and those which illustrate the chapter on tumors, the different elements of the tissues are brought out with striking distinctness.

**Selecting the Specimen.**—Specimens for microscopic examination should seldom be larger than one-half inch square by one-fourth inch in thickness; the smaller the better. The specimen should be cut from the gross material as soon as possible, for in all animal tissue putrefactive processes develop early, and soon spoil it for microscopic purposes. If the specimen is a tumor a piece should be taken from the center and also from the edge of the specimen; these should be put in separate bottles and marked to distinguish one from the other. In specimens consisting of several organs, as ovaries and tubes, cancers and glands, etc., a piece should be taken from each organ; with lymph glands whole glands which show enlargement, hardened or softened areas should be selected.

**Preservation.**—Always preserve the remaining gross material until the diagnosis has been made with the microscope. If the amount of gross material is small, preserve it in seventy per cent. alcohol, which should be replaced, after twenty-four hours, by ninety-six per cent. alcohol. Larger specimens, as breasts, kidneys, etc., are well preserved in Mueller's fluid. All specimens that are to be kept more than five days with a view to future microscopic study should be preserved in Mueller's, as alcohol over-hardens the tissue.

**Preparation of Stained Specimens.**—The first step is the "hardening" of the small pieces that have been cut from the gross material. Fill a wide-mouthed, four-ounce bottle with ninety-six per cent. alcohol; in the bottom place a thin layer of absorbent cotton or a crumpled layer of filter paper; put the small piece of the specimen in

the bottle and cork tightly. Label the bottle with the number of the specimen from the record book, the date, and the words "First Alcohol." After twelve or twenty-four hours empty this alcohol into a preserve jar which has been labeled "Waste Alcohol" and fill the bottle with fresh alcohol. Replace the old label by one bearing the number of the specimen, the words "Second Alcohol," and the date on which the second alcohol was used. At the end of the second day from the beginning the tissue should be examined to see whether it has been hardened sufficiently. It should be firm and resisting. If it is brittle it has been over-hardened; if it is soft and soggy it has not been hardened sufficiently. Over-hardening should be avoided by daily examination of material. Insufficient hardening should be remedied by placing a specimen in a third alcohol or by putting it through the process described in the next chapter as rapid embedding.

When the tissue is sufficiently hard thin sections may be shaved from it by a razor while the specimen is held in the left hand, firmly clasped between two pieces of soft cork, or, better, hardened liver. The razor should cut through liver and tumor tissue at the same time. This method is much inferior to cutting with the microtome. In microtome cutting, however, the specimen requires further preparation. It must be embedded in celloidin, in preparation for which it is taken from the alcohol and placed in a half-ounce, wide-mouthed bottle, half filled with a mixture of equal parts of ninety-six per cent. alcohol and ether. Here it remains from two to twelve hours, or over night; after which time it is transferred to the embedding fluid. The bottle should be labeled with the number of the specimen, the date when the fluid was changed and the letters "A. and E.," indicating the nature of the contained fluid.

Tissue left for many days in the alcohol and ether mixture becomes over-hardened.

**EMBEDDING.** For this purpose the best material is celloidin, which, in the wholesale drug trade, may be obtained in one-ounce bottles or cakes. The bottles are preferable, as in them the celloidin is powdered. To make the mixture half fill a pint bottle with equal parts of ninety-six per cent. alcohol and sulphuric ether, mix, and add one-half ounce of the celloidin. It must be shaken frequently as the celloidin does not readily dissolve. There results a thick, syrupy liquid which should have the consistency of molasses. This consistency can easily be varied by adding more of the alcohol and ether or of the celloidin. The solution should be well corked and kept on the staining table ready for use. When ready the specimen should be taken from the alcohol and ether mixture and placed in another clean, dry, half-ounce, wide-mouthed bottle, sufficient celloidin being poured in to cover the specimen, and a little more. The label on the bottle should be numbered and dated with the beginning of the celloidin process. The specimen is usually left over night in the celloidin or, if time permits, for five days. The celloidin soaks into the substance of the tissue and, when it subsequently congeals, holds the minute tissue elements or the contents of cysts and alveoli firmly in place; whereas in thin sections of tissue which have not been embedded many of these elements are liable to fall out in the subsequent handling of the section. The longer the substance is kept in the celloidin the more thoroughly will it be penetrated and the better will be the resulting sections. The tissue



may be left in the celloidin solution almost indefinitely, for the solution preserves the tissue perfectly and does not over-harden.

Never transfer a specimen directly from water to celloidin. If chromic acid, Mueller's fluid or other watery hardening fluid has been used after washing the tissue is placed in ninety-six per cent. alcohol for twenty-four to forty-eight hours to be dehydrated; it is then placed for twelve hours in the alcohol and ether mixture, and finally in celloidin.

Paraffine embedding has no real advantages but many disadvantages as against the celloidin process, and the method is in consequence omitted.

**MOUNTING FOR STAINING.** When the tissue has been in the celloidin for a sufficient length of time it must be mounted on a block or cork. Wooden pegs or spools are to be preferred to cork. The upper surface of the block must be clean and dry. A large drop of the celloidin is first poured on its surface; the specimen is lifted from the bottle with the forceps, quickly placed upon the drop of celloidin and arranged in such manner that the microtome knife will cut across the tissue in the desired direction. More celloidin is poured over the top of the specimen and is allowed to flow down to the upper surface of the block, thus enclosing the specimen in a mass of celloidin, which gradually hardens on the surface. If left exposed to the air the celloidin shrinks into a hard lump and spoils the specimen. It is desired that the celloidin shall harden into the consistency of firm cheese, for which purpose the block containing the specimen is immersed in a covered dish of chloroform, where it will harden in about half an hour; or it may be put in a mixture of two-thirds alcohol and one-third water, where it will require from two to six hours to harden properly. It is customary to mount the specimens on the blocks before leaving the laboratory, and to leave them over night in a covered dish of alcohol and water. In the morning they will be ready for a cutting. If the celloidin hardens too much it shows that there has been too much water and not enough alcohol in the dish.

**CUTTING.** The following description of the cutting of the celloidin blocks applies to the Thoma, Schanze, Bausch & Lomb, Leitz and all other microtomes where the knife is held in a sliding carriage. The block holding the tissue is placed in the clamp and the clamp is screwed down to its lowest point. The knife is adjusted. An ounce bottle of alcohol and a pipette stand at the left of the microtome. Both specimen and knife-blade must be kept wet with alcohol; otherwise the knife soon dulls and the specimens are not cut with the requisite delicacy. The knife should be so adjusted as to draw through the tissues from the heel to the tip, using, if possible, the whole length of the blade in making the section. The adjustment is screwed up until the knife cuts a thin layer from the top of the specimen; the instrument is then ready for making good sections. The number of turns of the screw required to obtain good sections varies with the different instruments and must be determined by practice, the object being to cut the sections with as few turns as possible. Here and there the knife will miss a section and cut the succeeding section very thick. This is often unavoidable. The cardinal points in microtome-cutting are to keep the blade and the specimen wet with alcohol and to have the knife sharpened frequently by a capable mechanic. Amateur strapping and sharpening will dull the knife more often than sharpening it. When cut the sections are removed from the knife-blade and

placed in a salt-cellar full of alcohol or water. Having cut as many sections as desired the block is removed and replaced in the dish of alcohol and water; then the microtome knife is wiped off with a soft cloth moistened with alcohol, especially the under side of it, where bits of tissue are apt to adhere. In a simple examination it is a waste of time to cut many sections; one or two thin slices are sufficient. If, on examination, the specimen is of sufficient interest to require further study more sections can be easily cut from the block.

When four or five blocks are cut at the same time the sections from them should be placed in separate salt-cellars; or, if their shape and size are sufficient to distinguish them, they may be all placed in the same dish.

If after microscopic examination of the tissue it is desired to preserve the specimen it should be cut away from the block and kept in alcohol or celloidin.

**STAINING.** The sections when cut are removed to the staining table where they are stained with hematoxylin and eosine. Of the many staining fluids which have been employed, the combination of hematoxylin and eosine has proved itself equal to all requirements. It stains rapidly, surely and uniformly, and the resulting microscopic pictures are unsurpassed as well for their beauty as for their distinctness and simplicity. Hematoxylin or logwood is a "nuclear stain;" it stains all nuclei deeply, leaving the cell protoplasm and the basic substance slightly or not at all colored. Eosine is a "ground stain" or "protoplasmic stain"; it stains all elements of a tissue a level red, having no especial affinity for nuclei. (See Plate, "Sarcomata.")

The staining table should be arranged in the following manner:

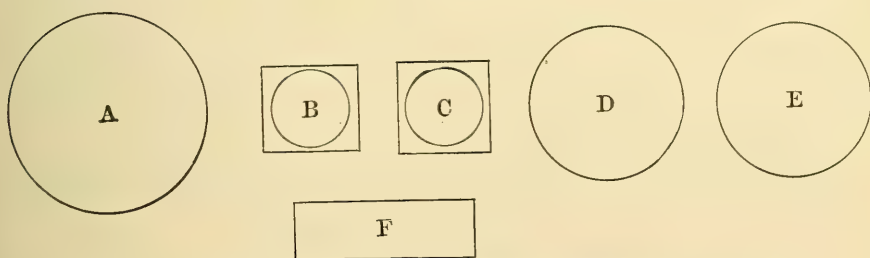


Fig. 7. Arrangement of Staining Apparatus.

A. A glass dish or soup plate full of water.

B. A salt-cellar containing dilute Delafield's hematoxylin solution, briefly described as follows:

Delafield's Hematoxylin. (Solution 1.) Three hundred c.c. saturated solution of ammonia alum in water.

(Solution 2.) Hematoxylin crystals (Merck), two grammes dissolved in 15 c.c. of alcohol. Mix the solutions in an open jar, and expose to light and air for four days; then filter, and add fifty c.c. of glycerine and fifty c.c. of Hasting's wood naphtha (pyroxylix spirit). Leave exposed to the light and air, and filter every second day until a sediment no longer forms. This solution grows darker with time and then requires dilution with water to prevent over-staining. When the hematoxylin is two months or more old, it is well to mix one part of the

solution to four parts of water in an ounce bottle, making the dilute Delafield solution. Instead of a cork this ounce bottle has inserted a small glass funnel with filter paper. In staining the solution is filtered into the salt-cellar, and after staining it may be filtered back into the ounce bottle.

The dilute solution may be renewed, when necessary, from the strong solution, which will keep almost indefinitely.

C. A salt-cellar full of water, to which has been added three drops of a saturated alcoholic solution of eosine. Eosine is purchased as a red powder—one-half ounce is sufficient. It is kept as a saturated alcoholic solution. All of the chemicals and stains mentioned may be purchased in the wholesale drug trade and from the dealers in microscopic supplies.

D. A covered glass cup containing one-half ounce of absolute or ninety-six per cent. alcohol.

E. A similar cup containing one-half ounce of Weigert's xylol mixture or oil of bergamot.

F. A piece of absorbent paper as large as an ordinary blotter.

*Methods.* (a) Immerse the section to be stained in water, A, and rinse for two minutes.

(b) With a teasing needle lift the section out of the water, let it rest on the absorbent paper to absorb the surplus water and then immerse in B, taking care that the section is not rolled or folded. Any folds must be straightened out. The time in B will vary according to the strength of the solution and the condition of the tissue. Tissues which have been well hardened when fresh stain easily. Autopsy material and material which has been removed from the body for several days before preserving often stain with difficulty. Richly cellular tissue, as lymphoid tissue or sarcoma, stains more readily than fibrous tissue, and is easily over-stained. If the hematoxylin solution has been freshly made it may require ten minutes to stain the section. If the hematoxylin solution is two months old or older it should stain readily in from one-half to three minutes.

(c) From hematoxylin the section is laid on the absorbent paper to get rid of the surplus stain and returned to A, where it should lie for at least five minutes. In the water the section turns a dark violet or purple color. If it does not turn at all violet it has probably not been stained sufficiently, and should be returned to the hematoxylin for a few minutes, after which it is brought back to the water. The best way to determine the depth of the staining is to mount the section on a glass slide, use no cover-glass and examine with a low power of the microscope. If the tissue presents small, black dots sprinkled over the field the nuclei have taken the stain. If no black dots can be discerned the nuclei are probably not yet sufficiently colored. If left too long in the hematoxylin the section may be over-stained, i.e. stained so heavily that the light does not penetrate it readily. In this case the simplest remedy is to stain a fresh section for a shorter time; or the over-stained section may be decolorized by pouring upon it a few drops of strong acetic acid and then washing in water. The section should then lie in the water for twelve hours, if time permits.

Sections stained with hematoxylin may be left in the water over night, or even for several days, without damage.



(*d*) From the water the section is laid again upon the absorbent paper to rid it of surplus moisture and then immersed in C for two minutes.

(*e*) It is then laid on the absorbent paper and brought back to A, in which it is rinsed quickly for ten seconds.

After eosine staining sections may be left over night either in water or alcohol. These fluids are apt to dissolve out the eosine, to remedy which replace the section in eosine for two minutes and continue as before.

(*f*) The section is now laid on a fresh, dry piece of absorbent paper until it is quite dry, but not to the point of shriveling, and then quickly put in D. The action of the alcohol is to dehydrate or absorb all the water from the tissue, and this action is materially hastened by previously drying the tissue on the absorbent paper as directed.

The mounting fluids, Canada balsam and dammar varnish, become clouded when brought in contact with moisture. For this reason any specimen which is to be mounted in them must be perfectly dehydrated. This action takes place in D, where the section should be left for ten minutes. To insure thorough dehydration some workers prefer to leave the section in the alcohol for five minutes and then to transfer it to a second alcohol for five minutes more. If one is staining many sections at the same time this is advisable, for the first alcohol gradually becomes saturated with water, which it absorbs from the tissues and from the surrounding air, and so does its work very imperfectly. For staining only fifteen or twenty sections one dish of alcohol is sufficient, especially if the sections are well dried on filter paper before immersing in alcohol.

In drying the specimens on the absorbent paper the section should hang from the end of the teasing needle so as to touch the paper. It should not be laid upon the paper, nor should it be allowed to dry so that it shrivels.

CLARIFYING. From D the specimen is dried on a fresh part of the absorbent paper and immersed in E. Balsam and dammar lac will cloud when brought in contact with alcohol as well as with water. Some solution is required, therefore, which will wash the alcohol out of the section, guard it from absorbing water and at the same time be miscible with balsam without clouding. The best agents for this purpose are, first, xylol, and, next, oil of bergamot. Weigert's mixture of three parts xylol and one part of carbolic acid crystals is the best. It is more satisfactory than bergamot, though the odor is not so agreeable, for when bergamot becomes a little old it will dissolve the celloidin in which the tissue was embedded. Delicate tissues deprived of their supporting celloidin are apt to fall to pieces in the bergamot. Xylol and bergamot not only answer the purposes mentioned above but they clarify the tissue, making it much more transparent and allowing the details to be more sharply and clearly seen. The value of this action can be best appreciated by examining a specimen with the microscope before and after immersing in the clearing agent. At first the section will usually float around on the top of the xylol or bergamot. In a few moments it will sink to the bottom and become noticeably clearer and richer in appearance.

**MOUNTING FOR THE MICROSCOPE.** The specimen is now ready for mounting on the glass-slide. A number of slides and cover-glasses, which have been carefully cleaned with the waste alcohol and ether mixture should always be ready in a covered box so that no time may be lost at this stage in cleansing the glasses. It is scarcely necessary to state that glass-slides or covers bearing finger smudges or other light obstructing matter are unfit for the mounting of tissues. The section may be taken from the xylol on a section lifter, which is a flat spatula; but the simplest method is to dip one end of the glass slide into the xylol and to float the section up on it by gentle traction with the teasing needle. The slide is then lifted out, dipping up on its upper surface a large drop of the xylol. The section is now floated in the xylol to the center of the slide. The surplus xylol or bergamot is absorbed by placing filter paper at the edge of the specimen, and applying a drop of the mounting fluid.

*Mounting Fluid.* The usual mounting fluid is Canada balsam dissolved in xylol, making a fluid of a consistency which will drop slowly from the end of a glass rod. The balsam is conveniently kept in a wide-mouthed ounce bottle, the cork of which is pierced by a glass rod which reaches to the bottom of the bottle. Balsam is sold in dry cakes or in flexible tubes. The dried balsam dissolved in xylol is the best, for the balsam in the flexible tubes is too thick and draws out in long threads. On thick balsam the cover-glass settles very slowly, and there is always an excess of sticky balsam around it. The drop of balsam from the glass rod should be spread over the entire specimen, and the cover-glass then applied. The cover is taken between the finger and thumb, and one flat edge is placed on the slide near the specimen. The cover-glass, still held between the thumb and forefinger, is slowly lowered upon the drop of balsam, driving the balsam before it. If the cover-glass is lowered faster than the balsam flows before it air bubbles will enter. If when the cover-glass is lowered in place the balsam does not come out to the edge of the glass a drop of balsam should be placed at the opposite edge, and the slide leaned against a book or cup in a slanting position so that the balsam may run under the cover and fill up the space.

A slide label should now be gummed at the end of the slide and a number corresponding to the entry in the Laboratory Book written thereon. The slide may be examined immediately or set aside for future study. It is well to make the examination at once, so that if the staining is imperfect another specimen may be prepared with the least delay.

*Appearance.* The appearance of the specimens after this treatment should be that of a red background on which are sprinkled a variable number of purple-black dots, depending upon the tissue which has been prepared.

These appearances may be studied in Figs. 1 and 2, Plate I, and in the colored plates that illustrate the chapter on tumors, all of which were drawn from tissue which had been prepared as described in the preceding pages. It will be noticed that all cell-nuclei are purple-black in color; and that the cell-bodies and all intercellular substance are red from the diffuse eosine stain. If the tissue so prepared contains areas of degeneration, as tubercular caseation or the colloid masses in colloid cancer, no purple nuclei nor well defined cell-bodies will be seen, but, as illustrated in the plate, simply a broad field of red, granular material,

which represents the mass of albuminous and fatty particles resultant from the caseation of protoplasm.

Red blood corpuscles, the cells of the stratum corneum and epithelial pearls become orange or golden yellow. Mucoid tissue and the mucous contents of the follicles of Lieberkuhn are usually stained blue or violet.

**Preparation of Unstained Specimens.**—With unstained specimens certain points in the minute structure of tissues may be learned which are obscured by the usual staining materials. Tissues hardened in alcohol are generally unfit for examination without staining, as the student may easily learn by examining such material. Glandular structures which have been preserved when quite fresh may show beautifully, but the majority of the specimens are very disappointing.

**HARDENING.** For the examination of unstained material, then, the tissue should not be hardened in alcohol but in chromic acid, which coagulates the albumin, stains the tissue slightly yellow, fixes it and usually brings out the structural details with great clearness. I say usually, because I have seen specimens prepared by the greatest advocates of this method, specimens which presented to the unenthusiastic eye nothing but a yellow blur with dim shapes struggling through the mist. Chromic acid is especially adapted to the preparation of bone and cartilage. Sarcomata and some carcinomata also give very clear pictures.

The pieces of tissue should be very small, not more than one-half inch square by one-fourth inch thick, and a one-fourth inch cube is a still better size. The chromic acid is used in a solution of 1-200 or 1-400, which must be frequently changed. The specimens should be placed in twenty times their bulk of the 1-400 solution for four hours; then in a similar quantity of 1-200 for twelve hours, and in a fresh 1-200 for two days. The tissue should be examined every day to see that it does not become tough. If not firm at the end of the third day it should be placed in a fresh 1-200 for several days more. The chromic acid must then be washed out with water.

**HAND-CUTTING.** If the tissue is to be cut by hand it may be placed between two pieces of cork or hardened liver and cut with a razor. Much better sections may be obtained by embedding in celloidin and cutting with the microtome. After washing it the tissue is placed in alcohol to be dehydrated. At the end of two days it is usually firm enough for alcohol and ether, celloidin and the microtome, as already described.

**CHROMIC ACID SECTIONS.** Sections made from chromic acid material should not be stained. The attempt to stain them with the nuclear dyes results in a diffuse, dirty opacity. They should be simply rinsed in water and mounted in pure glycerine. The section is floated up on a clean slide from water, in the same manner as has been described in xylol-balsam mounting. The surplus water is removed by absorbent paper placed at the edge of the specimen, and the section is covered by a large drop of glycerine. The cover-glass is applied as before.

**CEMENTING.** Glycerine does not harden and fix the cover-glass in place as balsam does. Specimens mounted in glycerine, therefore, are subject to injury from slight causes. Again, after a time the glycerine will evaporate and the specimen will spoil. For these two reasons the cover-glass, around its margin, must be cemented to the slide. Ordinary asphalt paint, to be obtained at a paint store, is excellent for this. Hollis'



glue, rubber cement, etc., appear on the catalogues of microscopic dealers, and are all satisfactory. It is well to use large seven-eighths inch covers for glycerine mountings, so that the cement margins may not encroach upon the specimens. The cement should not be applied immediately, but after twenty-four hours, when all water will have evaporated, leaving the pure glycerine surrounding the specimen. The edge of the cover-glass and the adjoining surface of the slide should now be wiped dry with a soft cloth, and the asphalt or other cement painted around with a small camel's hair brush, care being taken that the cement closes the aperture all around the cover-glass. Circular cover-glasses cemented by a turn-table are preferred by some, but the square cover-glass, neatly cemented by hand, looks equally well and allows more room to be devoted to the specimen.

Glycerine has a slow clarifying action, so that the specimens will be more distinct and satisfactory at the end of a week than when first mounted. As already observed this method is more for minute and leisurely study than for rapid pathological diagnosis.

### CHAPTER III.

## RAPID PREPARATION OF TISSUES.

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**Rapid Embedding.**—It frequently happens that a diagnosis is required sooner than the tissue can be prepared by the usual method. The quickest plan is to cut a thin section of the fresh tissue by hand or by the freezing microtome. In tissues presenting well marked characteristics, as carcinomata, certain sarcomata, and intestinal polypi, this method is satisfactory; but it often happens that the material which comes to the pathologist for diagnosis does not display its nature so easily. Sections of fresh tissue do not take the usual clear stains readily, and, therefore, the beautiful differentiation which is to be obtained by double staining is lost.

The plan which has served best in the hands of the author has been to place in a four-ounce bottle one or more very small pieces of the tissue, measuring not more than one-fourth of an inch in their longest diameter. The specimen may be one inch in breadth, provided that it is no more than one-eighth of an inch in thickness. The bottle is then filled with a mixture of two-thirds absolute alcohol and one-third ether in which a pinch of bichloride of mercury has been dissolved by shaking. With small specimens hardening is probably complete in from ten to thirty minutes, and certainly in an hour. At the end of thirty minutes, or as soon as the tissue is hard, it is placed in a half-ounce bottle half filled with thick celloidin solution, to which is added thirty drops of the tincture of iodine. The bichloride of mercury, which sometimes interferes with the subsequent staining, is converted into the biniodide of mercury, which salt does not affect the staining process. In ten minutes the specimen is mounted on a block with the least possible quantity of celloidin around it, then immersed in chloroform, and in twenty or thirty minutes it is ready for cutting with the microtome. When in haste the several steps of this process may be much shortened, the requisite judgment of time being easily acquired. In this way may be obtained broad, thin sections which stain easily and which are just as satisfactory as those prepared by the longer method.

**Fresh Tissues.**—There are three methods of examining fresh tissue: First, by cutting thin, free-hand sections with a razor or Valentine's knife, which is a knife consisting of a handle and two parallel blades; second, by freezing and cutting in a microtome; third, by isolating or teasing and scraping.

In practical pathological work little is to be learned by scrapings of fresh tissues or by examining the juice of tumors, unless for the study of bacteria and protozoa. The diagnosis usually rests upon the relations which one set of cells bears to another set of cells in their natural position; and this, of course, is best seen in sections of the undisturbed tissue.

In freezing pieces of the fresh tissue are placed directly on the freezing-plate of the microtome.

Sections of fresh tissue should not be placed in alcohol, but removed from the knife to a dish of water and mounted in a drop of glycerine, in which they will be preserved for some time. They do not take hematoxylin staining well.

The nuclei may be best demonstrated by a two per cent. watery solution of acetic acid to which sufficient fuchsin has been added to give it a deep red color. The stain is dropped on the tissue as it lies on the slide, and the surplus is absorbed with filter paper placed at the margin of the section. A one per cent. watery solution of methylene blue or methyl green is also of service.

**Isolation.**—Isolating or teasing of tissues is sometimes, but not often, of service in pathological diagnosis. A very small shred of the tissue under examination is placed on the slide in a drop of a three-fourths per cent. salt solution, and then torn into the finest possible fragments by two sharp-pointed “teasing-needles.” In this way the spindle-, round- and giant-cells of a sarcoma, the large, distorted or cuboidal epithelia of a carcinoma, or the spindle-cells of involuntary muscles may sometimes be recognized.

**Maceration.**—When a tissue does not “tease” readily, it is placed in a “macerating-fluid.” “Ranvier’s alcohol,” which is composed of one-third alcohol and two-thirds water, is useful; the small fragment of tissue is left in it for twenty-four hours. Mueller’s fluid is also an excellent macerating liquid; tissue should remain in it for three days. In macerating the volume of the fluid should not be much more than that of the specimen, lest it harden the tissue instead of macerating it. A salt-cellar, covered to prevent evaporation, is a convenient macerating vessel.

**Fixing.**—This term is used to express three different processes. When a section or a layer of sputum or pus is made to adhere to a glass slide, so that it will not wash off in subsequent staining, it is said to be “fixed.” The immersion of pieces of lung or kidney in boiling water or in a sublimate solution “fixes” any contained albuminous fluid by coagulating it. It is possible by immersing fresh tissue in certain solutions to render visible the nuclear chromatic net-work of the cells, and to “fix” the net-work in the position that it occupied during life. In this latter sense the word is here used. The different stages of mitosis in tumor cells can be well studied in this way. When placed in the fixing fluid the tissue must be absolutely fresh. Not more than half an hour should have elapsed from the time of removal from the living body, and the specimen must not be thicker than one-eighth inch nor broader than one-fourth inch. Mitosis can sometimes be studied by “fixing” autopsy material, but the examination of any but perfectly fresh tissue is apt to prove disappointing.

Mueller’s fluid, alcohol or chromic acid may be used, but they do not give as good results as Flemming’s mixture, made as follows:

Two per cent. watery solution of osmic acid four parts, one per cent. watery solution of chromic acid one part, glacial acetic acid one part; mix. The fluid should measure twenty times the volume of the specimen. It should be changed in half an hour and as often thereafter as it becomes clouded. After three days the specimen is “washed” for six hours and then hardened in thirty, sixty and ninety-six per cent. alcohol succes-



sively, embedded in celloidin, cut and stained with hematoxylyn and eosine. The Ehrlich-Biondi staining fluid also gives excellent results. This triple stain is prepared as follows:

Saturated watery solution methyl green, 5 c.c.; saturated watery solution methyl orange, 10 c.c.; saturated watery solution rubin s. (acid fuchsin), 2 c.c.

Before mixing the solutions, dilute each with forty volumes of water. The sections should remain in the stain from ten minutes to twenty-four hours. They are then rinsed in dilute alcohol, dehydrated for one minute in absolute alcohol, clarified in xylol and mounted in xylol balsam.

The Ehrlich-Biondi stain is much used for demonstrating the supposed parasites in the epithelial cells of carcinomata.

**Decalcifying.**—Suspected tuberculosis of bones and joints may usually be diagnosed by sections made through the adjoining soft tissue. Sometimes, however, it is desirable to obtain sections through bones; in which case the bone must be decalcified before it can be cut. The bone must first be cut in one-fourth inch cubes and hardened, preferably in alcohol, for from three to six days. It is then immersed in the following solution: Chromic acid, one part; distilled water, 100 parts; when dissolved add to this strong nitric acid two parts, and mix. It must be changed every third day until the end of the second week. The abstraction of the lime salts is determined by sticking the tissue with a needle. When there is no gritty substance left wash the tissue in running water for twenty-four hours, harden in alcohol and prepare as usual for stained specimens.

To wash tissue in running water it should be laid in a tumbler or deep dish of water, which is so placed in the sink that a stream of water from the faucet may continually fall into it. The overflow runs into the sink. If running water is not at hand the washing may be accomplished by soaking the specimen in four or more ounces of water, which should be changed every hour or two for twelve to twenty-four hours.

Very clear and satisfactory chromic acid preparations of bone may be made by immersing the cubes or bones in four ounces of a 1-200 chromic acid solution, which must be changed every second day, until no more gritty substance can be detected by piercing the specimen with a needle. The bone is usually ready in two weeks. It should then be washed in water, dehydrated for two days in four ounces of absolute alcohol, treated with alcohol and ether and imbedded in celloidin. These sections cannot be stained, but are to be mounted in glycerine.

**Injecting.**—The injection of blood-vessels is an operation used more in normal histological than in pathological research. It is unimportant in surgical diagnosis.

#### CHAPTER IV.

### PREPARATION OF CURETTINGS, PUS, SPUTUM.

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**Curettings.**—Curettings come to the pathologist as a mass of variously-sized shreds mixed with clotted blood. The appearance of these shreds and the presence on them of cutaneous, mucous or ulcerated surfaces should be noted in the gross description. If one of the pieces of tissue exhibits any special features, as a mucous or cutaneous surface, it should be prepared separately. As a rule it is well to harden the curettings in a single mass. The usual alcohol hardening or, preferably, the rapid hardening process should be used. A small funnel of absorbent paper which will go into a wide-mouthed four-ounce bottle is made; the curettings, blood and pus are poured into this funnel and the funnel with its contents is gently lowered into the bottle, which has either been filled with alcohol or the rapid hardening fluid. A ring of cotton or absorbent paper may be placed in the bottom of the bottle to insure the upright position of the funnel. The curettings and blood soon harden into a solid mass, which is run through alcohol, ether and celloidin, mounted and cut like any other specimen. In cutting it is convenient to spread the curettings over the block, so that one cut of the knife will give sections of several shreds. Sections should be taken from different levels that nothing may be overlooked.

The morbid appearances usually looked for in this material are epithelioma; simple suppuration, with granulation tissue; sarcoma; tuberculosis; and, in curettings from the uterus, adenomatous hyperplasia. The diagnosis of these conditions has been sufficiently outlined in the chapters which deal with the structure and recognition of tumors.

**Pus.**—For purposes of surgical diagnosis there are three methods of examining pus. First, a drop of the suspected fluid may be placed on a slide, a cover-glass applied and the preparation examined while fresh.

Second, for bacterial investigation the pus is usually smeared over a slide in a thin layer by pressing a drop of pus between two glass slides, which are then slid apart and allowed to dry in the air. The slide is then taken up in a spring clamp or clothes-pin, and the pus is "fixed" to the slide by passing it slowly three times through the flame of an alcohol lamp or, better, a Bunsen burner, the pus side being directed upward. The appropriate staining fluid is then dropped on the slide from a pipette, allowed to remain for two minutes, and rinsed off with a gentle stream of water from the faucet, or in a tumbler of water. In examining for the organisms of suppuration, or for gonococci, a one per cent. watery solution of methylene blue is used. The slide is allowed to dry in the air, and then examined with a one-twelfth inch oil-immersion lens. A drop of cedar-oil is applied directly to the blue film that covers the slide, and it is examined without a cover-glass. A slide so treated is a permanent preparation.

Third, the pus may be poured into a small, absorbent paper funnel, as described in the preparation of curettings, hardened in alcohol, and sections made in the same manner as with curettings. For bacteriological purposes these sections may be stained in the same way as ordinary tissue-sections.

In bacteriological investigation Gram's staining method is to be preferred in many cases. For the description of this process, as well as for more detailed information than is possible in this place, the reader is referred to any of the following text-books: *Methods of Practical Histology*, C. von Kahliden; *Pathological Anatomy and Histology*, Delafield and Prudden; *Text Book of Pathology*, D. J. Hamilton; *Practical Pathology*, G. Sims Woodhead.

**Sputum.**—Sputum may be examined in the same ways as already described in regard to pus, except that a different stain is used. The fresh examination of a drop of sputum under a cover-glass is unsatisfactory. Sputum from a case of common cold, catarrhal pneumonia and one of phthisis may be very similar, unless bundles of elastic fibres should be discovered in the latter.

The points of diagnostic importance in sputum are shreds of elastic tissue and tubercle bacilli. After having taken sufficient for bacillary study the elastic tissue is best found by boiling the sputum in an equal quantity of a twenty per cent. solution of sodium hydrate or potassium hydrate. The officinal liquors sodæ and potassæ are five per cent. solutions. After thorough boiling the sputum is mixed with four times its volume of water and set aside in a conical glass. When the sediment has well settled a drop of it is removed with a pipette, prepared with a slide and cover-glass and searched carefully for bundles of very fine hair-like fibrils, that are often twisted or curly. The fibrous frame-work of lettuce and other vegetable tissues which are common in sputum must not be mistaken for elastic fibres. When found elastic fibres are diagnostic of an ulcerative process in the lung, usually tubercular.

**Tubercle Bacilli.**—The finding of the tubercle bacilli is best accomplished by the Ziehl-Neelson straining process, which is applicable to the second or third methods, described under pus examination. The second method is the simplest and most commonly used. The slides are prepared and dried in the air in the same way as with pus. One of them is then "fixed" by passing it three times through the flame; but instead of using methylene blue the slide is covered with Ziehl-Neelson solution of carbol-fuchsin.

This Ziehl-Neelson or carbol-fuchsin solution is prepared as follows: Ten per cent. solution of fuchsin in alcohol, one part; five per cent. solution of carbolic acid in water, ten parts. Mix and filter. Filter from time to time as the sediment is precipitated. This is allowed to remain on the slide for three minutes, during which time the slide is kept hot by occasionally passing it over the flame. The stain must not be allowed to dry on the slide, fresh fluid being added occasionally with the pipette. The surplus stain is then rinsed off by holding the slide under the faucet and allowing a gentle stream of water to run over it. Everything in the sputum is now stained red with the fuchsin. The slide is next dipped in a tumblerful of twenty per cent. nitric acid and water for half a minute or until, on rinsing with water, the red color is no longer



visible to the naked eye. The acid solution decolorizes everything but the tubercle bacillus, which remains red. The slide is then rinsed in running water and covered with a one per cent. solution of methylene blue which is allowed to remain for two minutes. This colors the corpuscles, epithelia and bacteria in general blue. The tubercle bacillus remains red. The blue is washed off again with water, the slide is slowly dried over the flame or in the air and examined with an immersion lens. The tubercle bacilli appear as red rods, the length of which is about one-half the diameter of a red blood corpuscle. They are visible with a one-sixth or one-eighth dry lens and a one-inch or higher power eye-piece. The author has seen them demonstrated with a one-fifth lens and one-inch eye-piece, but this not often possible. The diaphragm should be arranged to give the largest orifice.

## CHAPTER V.

### TECHNICAL SUGGESTIONS FOR DRAWING.

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The following remarks refer principally to the drawing of microscopic preparations, though they are equally applicable to the study of gross specimens. Every pathologist should be a draughtsman. The principal value of drawing is not that it enables the pathologist to make fine pictures or to illustrate his writings, but that it teaches him to see what lies before his eyes. The microscopic view of a tissue is not an outline sketch, to be comprehended at a glance. It is a picture full of minute and elaborate detail, toward the arrangement of which myriads of tiny cells have labored for generation after generation. Such a picture requires for its comprehension a careful analysis of forms and their location, which is possible to most students, at least, only by copying the elements of the picture with pencil and paper. In his classes the author insists that each student shall devote some time to drawing from microscopic preparations, and he has had every reason to be satisfied with the result. In this way the student usually acquires an accuracy in his knowledge of pathological processes which forms a pleasing contrast to the indefiniteness and uncertainty that too often obtain.

As materials for drawing the student will require a blank book made of smooth, white, unruled paper, measuring about six by eight inches, and a medium hard lead pencil. Faber's No. 3, H or HB, and Dixon's No. 3 MH, H or VH, are good pencils. Remember that no one can make a sharp, clear line with a blunt pencil. The pencil point should, therefore, be sharpened frequently, and, for this purpose, a small, flat file and a sharp knife are convenient instruments to keep at hand.

Drawings intended for publication may be prepared as wood cuts or as photo-engravings, the latter procedure being known as "process." In the first case they are either redrawn on wood by the engraver or the original design may be drawn or photographed on the wooden block itself, in which case the engraver is presumed to follow the lines of the drawing and to produce a fac-simile of the original. Unfortunately, however, medical publishers are seldom willing to pay for the best class of engraving, and the finished picture is often a sorry representation of the original drawing. Even good engravers may fail in reproducing the artist's design. In the drawing there may be a personal quality peculiar to the artist, which the engraver cannot counterfeit. For these reasons the preparation and printing of drawings by process is to be preferred to manual engraving; and an additional reason for the use of process is the extremely low cost at which good work can be obtained. In process the drawing is transferred mechanically from one surface to another, and finally comes to the printed page exactly as it left the artist's hands, provided that the artist has complied with a few simple conditions.

There are many kinds of process, as each lithographer or photo-

engraver is apt to develop his own modifications to meet the demands of his customers. In most, if not in all of them, however, the first step is to photograph the original drawing. The only condition with which the artist must comply is to use such materials as will admit of every line of his drawing being photographed clearly.

These materials are smooth, white paper, jet black ink which leaves a dead black and not a shiny surface, and a lithographic pen. The paper should be white bristol-board of the best quality. It must be perfectly smooth or the transferred lines will be broken and uneven. If the pen cuts through the surface of the paper the board is not of good quality.

The most reliable black ink is Higgins' American India ink which is widely used by pen artists in this country and abroad. The best quality of China ink or India ink may be used, if care is taken to grind it until the solution gives a perfectly black line. There are in the market many cheap grades of India ink and they are all worthless.

Lithographic pens are simply steel pens which have very fine points and highly elastic nibs. There are many brands sold under this name, among which Gillott's "lithographic crow quill" is to be especially recommended. All of these materials may be obtained at art supply stores or stationers.

Drawing with the camera lucida is not to be recommended to the student. Free-hand drawing, which involves the use of the eye and judgment, is far better exercise than mere tracing. In an elaborate picture, however, the instrument may be of service in sketching in the outlines or the general grouping of the elements.

Among pen artists it is customary to make drawings two or three times as large as the required pictures. In photographing the drawing is reduced to its proper size and any irregularities or defects of the lines are likewise reduced to a size which is unnoticeable to the naked eye. This practice certainly results in a more finished picture, and, for such general subjects as landscapes or portraits, it is an excellent device. In the drawing of microscopic preparations, however, the author believes it to be a better practice to delineate the different cells and fibre bundles in exactly the same size as they appear through the microscope; for in endeavoring to draw all the elements of an elaborate picture two or three times as large as they appear the draughtsman is very apt to confuse the sizes.

For pen and ink drawings many artists make a preliminary pencil sketch. In microscopic drawings, however, after a little practice, this sketch may be dispensed with, or at most the general outlines of cell groups may be lightly indicated with pencil.

Colored drawings, as those in the accompanying plate and those which illustrate the section on tumors, may be made with a brush and pen, using colored inks to match the dyes. Even these may be reproduced by process—so that the cost of printing is made much more reasonable than if the picture required redraughting on the stone by the lithographer.

Always write under the picture the magnifying power at which the drawing was made. The almost uniform neglect of this point is a serious defect in books published in this country. Even such a standard work



on pathology as that of Delafield, where the really excellent illustrations were drawn by the authors, fails in this particular.

For the student there is little practical information in a picture which gives a group of granular bodies labeled "sarcoma cells," but which fails to state whether they are magnified by ten or by one thousand diameters. Our standard works on surgery and urinalysis are even worse, for they depict impossible tumor cells and jumble together ten varieties of epithelia in one picture, each epithelium being evidently drawn under a different magnifying power and no power being indicated for any of them. Until very recently Great Britain, France, and especially Germany, have surpassed us in the perfection of their microscopic illustrations. It is encouraging to note that certain books that have recently appeared show a marked improvement in this respect; and it is to be hoped that with improved facilities for illustration and a wider interest in microscopic pathology the medical text-books of the future will have in this country, as they now have in Europe, the benefit of the best that is known in illustrative art.

### SECTION III.

## SURGICAL ANESTHESIA.

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### CHAPTER I.

## SULPHURIC ETHER.

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**General Considerations.**—Anesthesia is, of itself, one of the most glorious achievements of a progressive age and constitutes one of the basal principles of all surgical triumphs.

It is of little interest to go farther back into the history of anesthetics than to state that nitrous oxide was discovered by Priestly in 1776. Some writers give the credit of this discovery to Sir Humphrey Davy. Others say that although he was not the discoverer he was the first to announce its exhilarating and analgesic effects and stated, in 1800, that it might be useful in surgical operations. It remained, however, for Horace Wells to demonstrate its practical value as an anesthetic in 1844.

The honor of the introduction of ether anesthesia was strenuously contested for by Dr. W. T. G. Morton, a Boston dentist, and Dr. Charles T. Jackson. To the former the credit is largely accorded because, in 1846, he produced successful surgical anesthesia in a public clinic in Boston. Later, records and testimony were produced showing that in the year 1842 Dr. Crawford W. Long, of Georgia, successfully etherized and operated a patient.

To Prof. James Y. Simpson, of Edinburg, belongs the credit of the discovery of chloroform anesthesia, he having announced it in 1847.

**Statistics.**—Ether, otherwise called oxide of ethyl, ethylic ether, sulphuric ether, etc., has the formula of  $C_2 H_5 O_2$ . It is prepared by the action of sulphuric acid upon alcohol. It is a highly volatile liquid, and its vapor is inflammable to a high degree. This should be remembered, not only during its administration but while pouring it from one can or bottle to another. If ether is pure it should be neutral to test-paper, and should remain clear if oil of copaiba be added. If there be water or alcohol present the addition of the oil will form an emulsion.

In America and Great Britain ether is now the routine anesthetic for general surgical purposes. This is due to its safety, which it possesses to a greater degree than chloroform, its most formidable rival for first place in surgical favor. The statistics of Dr. Julliard, published

in 1891, combined with those of Dr. Ormsby, of an earlier date, give the following:

ANESTHETIC.	Number of administrations.	Number of deaths.	Death rate.
Chloroform .....	676,767	214	1 in 3,162
Ether.....	407,553	25	1 in 16,302

According to these figures the administration of ether is not attended with one-fifth of the danger associated with chloroform anesthesia.

Although ether is the routine anesthetic for general surgery there are some contra-indications to its use. Enumerated briefly they are as follows: Renal affections, atheroma, asthma, emphysema and bronchitis, and it is generally avoided in the presence of fire and where the actual cautery has to be used within or near the oral cavity. At least four cases are reported in which the expired ether vapor became ignited and in one of them the patient's face was badly burned. Many object to administering ether if the patient be of the florid, obese, full-blooded type. Dyspnea from constricted upper air passages, tympanites and thoracic fixidity are offered by some as contra-indications to ether.

**The Patient.**—After acquiring a knowledge of the substances capable of producing anesthesia the first duty of the anesthetist is to study his patient. This has hitherto been neglected but its importance must now be realized; for the range of anesthetic selection has increased to the extent of throwing discredit upon the custom of anesthetizing all classes of patients with the same anesthetic. It is necessary to study the patient in order to select that anesthetic and that method of administration which offer the greatest measure of safety to the patient.

The effects of anesthetics differ somewhat in the different sexes. Women, as a rule, are more easily anesthetized than men, although the difference is less pronounced when both have reached advanced age and the disparity in muscular development is less marked. This fact seems to be in keeping with the report that out of two hundred and ten deaths from chloroform one hundred and fifty occurred among males as compared to sixty among females.

**AGE.** It is generally thought that age, *per se*, modifies the influence of anesthetics. It is more than likely, however, that such modification is due to the difference in the general physical or organic status of the patients at different periods in life. Neither extreme of life, infancy nor senility, offers, of itself, any contra-indication to the administration of anesthetics, although it may afford reasons for selecting different anesthetics and for varying the mode of administration. And here it may be well to correct an error that prevails to a considerable extent. Children have no immunity from the dangers of anesthetics. In Comte's collection of two hundred and thirty-two deaths from chloroform twenty-one were among children. The anesthetist is allured into the use of this form of anesthesia rather than that of ether because it is more rapidly induced and is freer from gastric and respiratory irritation. The latter



can often be avoided by exercising care and administering ether vapor gradually. If the respiratory irritation be only sufficient to produce somewhat coarse and noisy breathing sounds it is not especially objectionable, for it enables the anesthetist the more readily to satisfy himself as to the depth of anesthesia and the working condition of the respiratory organs and centres. Usually the respiratory efforts during chloroform anesthesia do not afford these advantages because they are so noiseless and the sleep so tranquil.

The brief employment of nitrous oxide or chloroform as a primary anesthetic may be resorted to for the purpose of obviating the child's cries and struggles.

Senility, except for its associated debilities, offers advantages rather than disadvantages for the induction and maintenance of surgical anesthesia. This is probably due to the fact that there is less muscular vigor and excitability to overcome and consequently less of the anesthetic is required than is usually necessary in adult life; nevertheless, the anesthetist must remember that old age is attended with degenerative changes, such as renal, cardiac and vascular, which offer the highest degree of encouragement to anesthetic complications, either incidental or subsequent to operation. Then to these must be added the thoracic fixidity of advanced age which so seriously impedes respiratory expansibility and contractility that caution must be exercised in order that the additional task of breathing during anesthesia may not fatally fatigue the respiratory centres. Chloroform is here generally considered preferable to ether, because with the latter the respirations are usually deeper and more frequent.

**TEMPERAMENT.** Patients with highly strung and highly sensitized nervous organizations do not take anesthetics as kindly nor remain as easily controlled thereby as the placid patient with relaxed temperamental tension. Reflex phenomena are quite likely to manifest themselves during anesthesia in hysterical or highly nervous patients, who are also prone to exhibit strange emotional tendencies during the recovery from the anesthetic state.

**TYPE.** A patient who has suffered from previous invalidism, if not too severe, will usually take an anesthetic more kindly than the vigorous, muscular patient, especially if in the latter type the transition from active outdoor life to the anesthetizing room be very sudden. Here, general muscular excitability and spasm of the respiratory muscles are of frequent occurrence. Emaciated and anemic patients usually pass easily and quickly to insensibility and require but a small quantity of an anesthetic. On the other hand, obese and florid subjects, especially if hampered by a thick heavy beard, which allows the admission of air, require greater quantities of the anesthetic and are less tolerant of its influence upon the respiration. The face of the florid high-liver becomes dusky and cyanosed if the vapor is not administered cautiously. Chloroform is better than ether for such patients.

**DRUGS.** Drugs are known to interfere with the action of anesthetics. This is especially true of alcohol. The continued use of morphia or chloral is supposed to render the system less susceptible to the induction of anesthesia. Some writers believe the same to be true of tobacco. When used excessively it may render the pharynx and larynx so irritable that coughing ensues when the anesthetic vapors come in contact with

them. In habitual alcoholics it is sometimes a positive impossibility to produce profound anesthesia without the previous administration of a dose of morphia. Ten grains of chloral-hydrate are occasionally recommended for the same purpose. If such patients are not addicted to the use of morphia an eighth of a grain administered hypodermically, from twenty to thirty minutes before operation, will usually suffice. Some give one-fourth of a grain, but the smaller dose is safer and can be repeated if necessary. The few fatalities that have occurred during or after this mixed narcosis may probably be charged to over-dosage, one-fourth or one-third grain having been administered. I regard this as unsafe, unless the patient's tolerance of the drug has been previously tested. If the small dose is insufficient it can be repeated during the process of anesthesia or operation. There can be no question that in the case of an alcoholic or an excitable muscular or highly-strung subject there is much less tendency to spasm and excitement if morphia has been previously given. Preceding ether, morphia should be combined with atropia, which tends to prevent the excessive collection of saliva and mucus in the pharynx and bronchi. Much less of the anesthetic is required if its administration is preceded by an injection of morphia. It has been found, also, that the frequent induction of the anesthetic state begets a certain degree of tolerance for anesthetic substances, and that larger quantities may be required from time to time.

**RESPIRATION.** The character of the breathing should be carefully noted before the anesthetic is exhibited. Otherwise pre-operative peculiarities in respiration might be attributed to the anesthetic. If the air passages are constricted or impinged upon by abnormal growths, inflammatory or other influences, and the patient suffers from dyspnea, anesthesia is attended with unusual risk. Such conditions may demand tracheotomy at any moment. Chloroform is generally preferred in these cases. If in addition to dyspnea the patient suffers from orthopnea, and especially if due to some acute pulmonary, pleural or bronchial disease, it may generally be predicted that the anesthetic will be badly borne. Probably the most danger attends upon an acute pleural effusion, and it is advisable to operate such cases with cocaine anesthesia. If general anesthesia is to be induced the patient must not be placed upon the sound side. The upper side is the breathing side. The one beneath cannot expand, therefore the healthy side must be upward. Long-standing lung and pleural lesions give rise to far less difficulty because the respiratory apparatus has become more or less accustomed to the impairment.

Ether is not usually borne well by asthmatic or emphysematous lungs. In the latter the breathing will often appear to be wholly abdominal in character. Or it may apparently be entirely thoracic in character, due to abdominal distension. Either condition demands care in the use of anesthetics. To favor respiration all operations should, whenever possible, be performed with the patient lying upon the back instead of the side. If there is partial or complete nasal obstruction a small mouth prop with safety string attached may be inserted to keep the jaws separated. This is not essential if there be some teeth missing, for the openings thus left will serve for the admission of air, should the jaws be brought together.

**PULSE.** The anesthetist should inform himself as to the condition of the circulation before the anesthetic is administered. Little uneasiness

need be felt at the high pulse rate, so often found in highly emotional subjects. This usually improves as insensibility ensues. The "pipe-stem radials" and general atheroma enhance, somewhat, the dangers of anesthesia. This is mainly in the direction of cerebral hemorrhage. Efforts must be made to give the anesthetic so gradually that excitement, coughing and struggling may be avoided. Vascular turgescence is less likely to be induced by chloroform than ether. Aneurism requires the same care. If the pulse is slow and full, indicating the cardio-vascular changes accompanying renal lesions, chloroform or nitrous oxide should be given in preference to ether; although of late it has been shown that the influence of chloroform on the kidneys is more severe and more like that of ether than was formerly supposed. Patients with cardiac lesions do not offer as serious obstacles to anesthesia as might be supposed. They generally take anesthetics well, although they should never be anesthetized except in the recumbent position, and should be watched carefully. Ether or nitrous oxide is the safer anesthetic in such conditions. Some recommend the a. c. e. mixture—alcohol, chloroform and ether.

Collapsed or moribund patients, or those suffering from shock or cerebral pressure, may often be operated without an anesthetic. If its administration be necessary, however, it should be given sparingly; although the pulse may at first improve this may soon be followed by irregularity and feebleness. This is especially true in cases of intestinal obstruction with a markedly distended abdomen.

**PUPIL.** The size of the pupil will be noted before beginning the inhalation of the anesthetic. This is necessary in order that the deviations from the normal may be recognized while anesthesia is being produced or maintained. Although the normal pupil is extremely variable under ether the anesthetist will remember that the pupil of old age is often immobile under anesthesia of any variety. This may be predicted, sometimes, if the eye shows an arc or ring of fine calcareous deposit at the sclero-corneal junction, known as the arcus senilis, or annulus senilis,



Fig. 8.

which is a visible sign of tissue degeneracy. Figure 8 will illustrate:  $2\frac{1}{2}$  mm. is the size of such a pupil as above referred to before anesthesia, and  $2\frac{1}{2}$  mm. is the size when photographed during profound anesthesia. It is immobile. Allowance must be made, too, for the pupil that has been dilated with atropia or belladonna, or contracted by morphia.

**Preparation of the Patient.**—It is wise to have the patient remain in bed for twenty-four hours before operation, when possible. No solid food should be given during the day of operation and there is less liability of vomiting if no fluids have been given for three or four hours preceding the administration. A purgative should be given the previous evening, or if the operation is to be in the region of the rectum or genitals it is better to evacuate the bowels twenty-four hours before. Purgation must not be sufficiently free to produce exhaustion. Except in emergencies, where immediate operation is necessary, the urine should be analyzed. The heart and lungs should be examined tactfully, so as to avoid alarming the patient. The condition of the vital organs before operation should be recorded. As with all other anesthetics there should be a third person present whenever ether is administered.



It is generally admitted that the morning hours are preferable, especially for nervous and apprehensive patients. The oral cavity should be inspected for the presence of false teeth, tobacco, etc. The clothing should consist of a night dress or shirt, and even that loosened at the throat. Should complications arise it will be found difficult to deal with them if the patient be dressed as for every day life, and many anesthetists and assistants can speak feelingly of the inadvisability of anesthetizing patients with their boots on. The recumbent, and whenever possible, the dorsal position should be insisted upon; for, putting exceptional cases aside, there is less respiratory embarrassment in this position than in any other. Generally speaking a patient should never be anesthetized unless tongue-forceps, mouth-gag, hypodermic syringe and cardiac and respiratory stimulants are within reach. Tracheotomy instruments and an appliance for intra-venous (or intra-cellular) saline infusion should not be forgotten. Under no circumstances should the patient be compelled to view the operator and his assistants in long white gowns and with bared arms, or a glittering array of instruments, threaded needles, sponges, basins, etc. The patient ought to be anesthetized in another room and brought in. Or, the instruments may be prepared in an adjoining room and brought in after the patient becomes unconscious. The patient should never be asked to clamber upon the operating table in the midst of a surgical display. No noises, such as rattling of instruments, talking or laughing, must be allowed to reach the patient's ears, either before or during the administration of the anesthetic.

The temperature is sub-normal during ether anesthesia, and the room must therefore be warm and undue exposure avoided. It is a good plan, especially if the lithotomy position is necessary, to have each of the lower extremities wrapped in small woolen blankets and these covered with mackintosh. To avoid an unnecessarily prolonged period of anesthesia the operative field should be previously prepared by washing, scrubbing, shaving, etc.

**Administration.**—The surgeon should be sure that the anesthetic is from a reliable manufacturer, and that it has not become vitiated by being allowed to stand in badly stoppered cans or bottles. It is safest to use small cans and open fresh ones for each administration. Except in special emergencies it should never be entrusted to unprofessional hands, nor should it be confided to an unskilled member of the profession, as is too often the case. The anesthetist ought to have special instruction as to the various phenomena that attend the anesthetic state and be thoroughly acquainted with the methods of coping with the accidents or complications that may arise. He must understand that the patient whom he has rendered insensible is in a condition the tendency of which is toward death, and consequently demands his most conscientious attention. He must have no eyes for the operation, no ears for the conversation that may be carried on. Nothing so quickly betrays ignorance, carelessness or lack of proper training on the part of the anesthetizer as his efforts to watch the various steps of the operation.

**INHALERS.** Pages might be devoted to the discussion of inhalers, some surgeons preferring one kind, some another. Probably none gives more general satisfaction than the cone formed of a towel folded over a piece of paper. It is always available and clean.

Both the Allis (Fig. 13) and Clover inhalers have many admirers. The employment of the Clover apparatus represents the closed method of etherization, the Allis inhaler the open method. The latter method, while not economical, is far more frequently employed. Only a small quantity, say a drachm or even a half drachm, should be poured upon the inhaler at first. It ought to be well distributed, whether it be in a towel cone or upon the Allis inhaler, and then made to approach the patient's face gradually, the act being accompanied by a few encouraging words. Many patients are instinctively apprehensive and a little tact and the avoidance of a too concentrated vapor at first may obviate a period of furious excitement and struggling. The vapor is irritating to the mucous membrane of the respiratory tract and readily induces coughing and attempts at deglutition which only retard the work of the anesthetist. The drenching method is not to be recommended. Beginning with a small quantity of ether, allowing a rather free admixture of air, and exercising patience till the respiratory tract becomes accustomed to the vapor the most intractable patient will usually be subdued without frenzy or violence. There is a horrible sense of suffocation attending the too sudden approach of the pungent vapor which is maddening and provocative of the most frenzied resistance on the part of the patient who feels that he is being deliberately stifled.

**The Process of Anesthesia.**—Anesthesia is divided into three stages, probably more for convenience of description than because they are matters of actual demonstration; at least in the majority of well conducted cases of anesthesia if the stages exist at all they are confluent and cannot be demonstrated.

**FIRST STAGE.** The first stage or period is the beginning of insensibility. If coughing and swallowing are prevented the patient will be taking deep inhalations (and possibly be counting aloud according to instructions), and these will proceed rhythmically, becoming deeper and more rapid and noisy than normal. The pulse is fuller and quicker, and the special senses are disturbed—as by flashes of light before the eyes, singing, hammering or roaring in the ears. A moderate degree of analgesia, called “primary anesthesia,” is said to be induced during the early process of etherization. It is said by some that during this period, although it is quite evanescent, short operations may be performed—as opening an abscess, for instance. This idea has not as many advocates as it formerly had.

**SECOND STAGE.** This is a stage of excitement. The patient seems intoxicated and may sing or shout wildly. He may answer questions more or less incoherently and display an unusual degree of volubility. The pupils are mobile and variable though usually somewhat dilated. There may be general muscular spasms or clenching of the teeth from spasm of the masseters, or the ether tremor may occur. Mucus is secreted freely, the face is flushed, the skin may become moist from perspiration, the conjunctivæ are injected and the pulse is full and bounding. The breathing at times becomes irregular on account of muscular spasm, and frequently there occurs a temporary cessation of respiration, which may be due to the spasm or to “anesthetic forgetfulness,” or sometimes to respiratory resistance. Though apparently unconscious there is an effort made to avoid further inhalation of the vapor. All these difficulties are frequently

caused by the use of a too strong vapor. The breathing grows more regular as anesthesia progresses. Muscular relaxation and unconsciousness demand that the lower jaw be held by means of the fingers being pressed forcibly behind the angle of the jaw. The respirations may gradually deepen into stertor, and the third stage is reached.

**THIRD STAGE.** The period of surgical anesthesia is characterized by general muscular relaxation (if the arm be raised it drops like an inert mass), by stertor or deep, regular and noisy breathing, and an insensitive cornea. The temperature begins to fall soon after the inhalations begin being lowest when the ether is used most abundantly and when anesthesia is deepest. The pupils should be watched, not because their size is a reliable guide as to depth of the anesthesia, but rather as affording some corroborative evidence. Its variability in some patients is accounted for by a peculiar susceptibility to reflex dilatation, due to some of the surgical measures that are being carried out. It varies in different subjects, and

the accompanying figure shows the variability in the same patient during a satisfactory etherization. That is, from  $2\frac{1}{2}$  to  $4\frac{1}{2}$  mm. In 150 cases Kappeler found that the pupil was contracted in thirty-seven during deep etherization. One of



Fig. 9.

the most important things in regard to the pupil is that the widely dilated and immobile pupil is augural of collapse.

**Maintenance of Anesthesia.**—Satisfactory anesthesia having been induced, the anesthetist must endeavor to maintain an even degree of anesthesia. This can be done by closely watching for lid-reflex, vomiting and rigidity, or deep-drawn, sighing respiration, any one of which may indicate approaching sensibility and demand that more ether be added. The best guide as to the exact level at which etherization should be maintained is the respiration. Adding a fresh supply of ether usually increases the rate, depth and audibility of the breathing (puffing of the lips with expiration is not uncommon), and these signs gradually diminish as the depth of narcosis diminishes. Swallowing movements also indicate a tendency to emerge from deep narcosis.

A fact that cannot be ignored is the frequency with which subjects are anesthetized to a degree that is unnecessary. Muscular flaccidity can sometimes be enhanced by giving the patient more air and then pushing the ether again for several minutes. Or, after employing ether for a reasonable time without producing relaxation, a little chloroform may be substituted, after which relaxation may be easily maintained with ether. It must be remembered that muscular rigidity is sometimes due to the fact that the air passages are not free.

If much blood is lost during the operation less ether is required. All operations do not require the same degree of anesthesia. Quiescence and relaxation are so essential in abdominal operations that continuous and deep anesthesia is demanded. Again, operations upon the perineum and rectum may demand profound narcosis while the cervix may be operated under very light anesthesia. The anesthetic can often be suspended before the operation is terminated, for the reason that the patient is sufficiently charged with ether to maintain analgesia, at least until the operation is completed. As before stated, ether is often given in unnecessarily large quantities and deep and prolonged stupor may succeed the withdrawal of the anesthetic.



**Management of Difficulties and Accidents.**—From what has previously been said the anesthetist will understand that it is by uninterrupted vigilance that the patient is protected from disaster and the operator from disgrace. There has been too great a tendency to hold the operator responsible for calamities that occur from anesthetics. He is not responsible unless he entrust the anesthetic to an incompetent person, or prolong the operation against the dissent of a skilled anesthetizer. There will, however, be fewer embarrassments, fewer accidents and fewer deaths if the surgeon adhere to the following rules: 1. Procure the best anesthetist obtainable. 2. Pay him well for his services. 3. Make him earn his fee.

Bad breathing may result from intolerant respiratory mucous membrane. This may be obviated by permitting the vapor to be well diluted with air, and approaching the face with the inhaler very gradually. If this is not successful it will be necessary to change to some other anesthetic, as chloroform, nitrous oxide, or possibly the a. c. e. mixture. Or, if it is preferable to give ether, a hypodermic injection of  $\frac{1}{8}$  grain of morphia will decrease the respiratory irritability sufficiently, for the time.

**MECHANICAL OBSTRUCTION.** The patient may breathe through either the mouth or nose, and this must not be forgotten in looking for the cause of obstructed breathing. The lips may fall together with a puffing and flapping motion during inspiration and expiration, thus usually obstructing the latter. This is easily relieved by retracting one lip so that their margins are not drawn together with each inhalation. The alæ nasi may also be relaxed sufficiently to be drawn inward against the nasal septum by the forcible inhalations and thus obstruct inspiration. This is very easily relieved by the introduction of self-retaining nasal specula, or any instrument to hold the wings of the nostrils outward. The most frequent cause of obstruction is the contact of the base of the tongue with the pharynx, probably from the abnormal engorgement and relaxation. The great majority of the elements of bad breathing are obviated by holding the lower jaw well forward, and sometimes pulling the chin away from the sternum as shown in Figure 10.

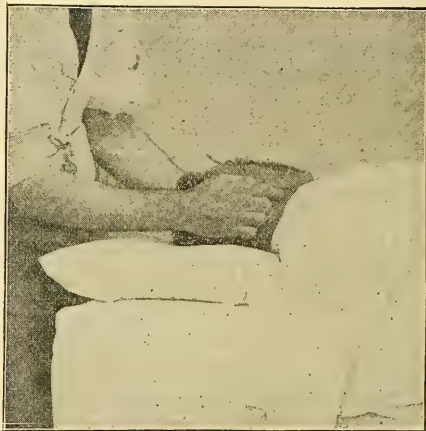


Fig. 10. Position of Jaw.

Should it be found that the upper teeth overhang the lower they must be disengaged, and the lower jaw pushed forward from behind. At times this requires that considerable force be exerted on both sides behind the angle of the jaw.

Spasm of the masseters enhances this difficulty. Turning the head to one side is then a useful procedure. If there be a collection of mucus in the pharynx it should be wiped out with a small wad of absorbent cotton held firmly in a pair of forceps. If none of these measures afford relief the jaws must be separated and the tongue caught by forceps

(Fig. 11.) and drawn well forward. The teeth should be forced apart by a blunt instrument, a wooden wedge or a screw-gag. (Fig. 12.)

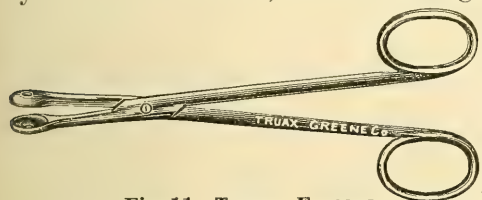


Fig. 11. Tongue Forceps.

Or, without waiting for these, the forefinger may be forced through the buccal cavity, between the jaws, back of the teeth, and the base of the tongue drawn forward. If the breathing is still embarrassed, the finger should be swept over the base of the tongue

to raise the epiglottis. The thorax should be compressed forcibly with the hope that the expulsion of the pulmonic gases may clear the obstruction. Laryngeal spasm, resulting in high-pitched, crowing or stridulous breathing, is generally accounted for by incomplete anesthesia and may often be relieved by administering the anesthetic freely. If, however, this character of breathing is accompanied by a dusky cutaneous surface more air instead of more ether is indicated. Forced artificial respiration must be tried when the thorax becomes fixed by reason of general respiratory spasm. Stretching the anal sphincters may also be tried. (See Respiratory Failure below.)



Figure 12.  
Screw Gag.

**VOMITING.** This is always unwelcome on account of the danger of vomited matter finding its way into the larynx and bronchi. When the epigastrium begins to heave and vomiting is threatening the ether may be used plentifully. But when emesis occurs the patient should be turned well over, face downward if possible, and the ejecta cleared from the mouth and pharynx. If the respiration is then free the ether may be pushed again. If the above measures fail the obstruction is probably below the larynx and requires the introduction of a laryngeal catheter (Kappeler), or tracheotomy must be done quickly, and artificial respiration resorted to and continued till respiration proceeds unaided, or until it becomes evident that further efforts are useless; this may require an hour.

Thus far nothing has been said about respiratory stimulants, for the reason that mechanical obstructions alone have been considered.

**RESPIRATORY FAILURE.** This may result from a variety of causes, such as diseases of the respiratory system, distended abdomen, syncope, asphyxia and a toxic quantity of the anesthetic. Some have suggested that the preliminary exhibition of morphia may encourage the tendency to respiratory failure. If the morphia be used judiciously, i. e. if administered to a proper subject, the dose not to exceed  $\frac{1}{8}$  grain, there is little likelihood of producing other than the desired results.

When respiratory failure is threatening the breathing will be intermittent, shallow, jerky or catchy. Good color of the face, ears and lips, and full, regular pulse are occasionally consistent with feeble respiration; but if there co-exist a grayish, dusky, pallid or cyanotic facial hue respiratory cessation is imminent and the anesthetic must be removed at once. In simple cases it may be all-sufficient to employ pectoral flagellation with the end of a wet towel. Or, rubbing the lips with a dry towel and pouring a little ether or cold water upon the bare epigastrium may be



tried. If this be not sufficient the surgeon should stand at the patient's right side, grasp the thorax fronto-laterally and make firm and rhythmic pressure. If respiration is continued but feebly inhalations of aromatic spirits of ammonia will be helpful. It may be injected hypodermically, five to ten drops. In some cases sulphate of strychnia has been found useful as a respiratory stimulant. I have never given more, at a single dose, than 1-100 grain hypodermically. Of course it is understood that during all these procedures the lower jaw has been kept in position as before advised. The patient may be inverted, the lower extremities raised and the head lowered. The necessity for resorting to the above measures may sometimes be obviated by stretching the sphincter ani, a method of no inconsiderable value and for which we are indebted to Pratt. The thumbs are well introduced into the rectum and the sphincters forcibly stretched, then relaxed, and the procedure repeated as the occasion demands. In cases of complete respiratory cessation this has been followed by prompt renewal of respiration. It will not always do it, however, neither will any single one of the foregoing measures. The most important of all our aids is artificial respiration, after Sylvester's method. There are recorded instances showing that it was necessary to persist in this treatment for one, two, and even four hours before automatic respiration was established. Faradization of the phrenics is regarded by many as of doubtful utility, and by all as far inferior to Sylvester's artificial respiration.

**CIRCULATORY FAILURE.** This is often dependent upon some form of respiratory embarrassment, such as has been described above; in which case it would be folly to treat the secondary phenomena and ignore the primary. Occasionally, however, the circulatory apparatus begins to fail before respiration is at all affected. This may be from sheer inability to cope with the toxic influence of the anesthetic or with some extra strain—as vomiting, for instance. Patients who are extremely exhausted from disease or shocked from accident, and those who are suffering from profound mental depression, cardiac affections (valvular or otherwise) and vascular degeneration, seem to encourage circulatory failure. The exhausted patient may be stimulated by enemata (*vide infra*), and the anesthetic used sparingly. Enemata are advised instead of stimulants by the oral route because of the tendency of the latter to provoke vomiting. The operating room must be warm and the patient well blanketed and surrounded with hot water bags while on the operating table. The patient who is deeply depressed mentally must be buoyed up with hope and an air of confidence. The relatives may be told the plain truth, but such a patient's life may depend upon the hope he derives from deception as to the real danger he is about to undergo.

The subjects of valvular lesions, with feeble circulation, may require five to ten drops of tincture of digitalis before the operation. Some give 1-100 to 1-50 grain of strychnia, hypodermically, for the same purpose. Vascular degeneration has been touched upon on page 95.

The surgical operation, asphyxia, vomiting or overdose of the anesthetic may excite circulatory failure or depression. The operation may necessarily be accompanied by severe hemorrhage, and the circulation be consequently depressed; or the sudden change in the position of the heart after paracentesis thoracis, or the sudden evacuation of a large quantity



of fluid from the abdomen may be followed by ominous circulatory signs. The symptoms of cardiac failure are unmistakable. The face is pale and ghastly, the pulse is feeble, flickering or absent, and the pupil may be found widely dilated. If these symptoms appear to be due to surgical shock the operation must be abandoned, unless they subside under the following treatment: First, be assured that respiration is free. Elevate the foot of the table or, better, have a stalwart assistant place the flexure surface of the knees over his shoulder (with his back toward the patient) and grasp the legs firmly; the patient can thus be inverted to any desired angle. If necessary the patient may be lifted from the table, with the legs in the above position, and the body allowed to dangle, while artificial respiration is carried on—in order to eliminate the anesthetic vapor—and cardiac stimulants are administered hypodermically. Five to ten drops of digitalis, two drops of the one per cent. solution of nitro-glycerine, 1-30 grain of spartine sulphate, ten drops of aromatic spirits of ammonia, and fifteen drops of benzoic acid mixture,\* are among the best stimulants from which a selection may be made. If the collapse is due to surgical shock or general exhaustion and not to the toxic influence of the anesthetic it is considered rational to administer brandy or whisky hypodermically; but in many cases it is impossible to make such a differentiation, and so the utility of alcohol is regarded with some doubt, though still used somewhat indiscriminately. Nitrite of amyl may be tried by inhalation, and ammonia likewise.

Maas' rapid rhythmic and forcible compression of the cardiac area is said to be useful. The sphincter ani may be stretched and the effects carefully watched. Hot black coffee is an excellent cardiac stimulant. A pint may be injected into the rectum and, if necessary, held in by pressure upon the anus until absorption can take place. On more than one such occasion the patient has complained of the taste of coffee in less than ten minutes after the injection. Some have found rectal injections of whisky and valerianate of ammonia, one ounce of each, to be useful.

Intra-venous saline infusion is one of the most important measures. Nor does this require any complicated apparatus. All that is necessary is a few feet of rubber tubing and a glass tip to enter the vein. The glass from a medicine dropper or pipette answers very well. A drachm of common salt to a pint of warm water is generally used, but if one is in a hurry, and such is usually the case, it is unnecessary to wait for proportions. Inject warm salt water into a vein of the leg or arm till the pulse begins to fill, then wait and repeat if necessary. What artificial respiration is to respiratory failure intra-venous infusion is to circulatory failure.

**After-Effects.**—Those most common are nausea and vomiting, and it must be confessed that they cannot always be obviated, even by the most satisfactory administration and the most careful regulation of the diet for several hours preceding operation. It is not questioned, however, that these undesirable and often distressing phenomena are frequently the result of improper feeding; as, for instance, liquid food immediately preceding the operation, or solid food from three to five hours before. Sometimes the retching and vomiting are distressing, lasting for hours and perhaps rendering the stomach intolerant of food for days. At other times

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\*Benzoic 1.5 gramme, camphor 1 gramme, rectified spirits 12 grammes.

these are transient, occurring just as the patient is emerging from the anesthetic influence. If the operation has been protracted and a large quantity of the anesthetic used, general malaise, furred tongue and anorexia may exist for days. The breath is foul and the mental and bodily powers seem sluggish. This is probably due to the fact that physiological metamorphosis has been interfered with by the toxic action of the drug, and the excretory system has become clogged by the metabolic debris. The urine should be examined before and after every operation; from time to time evidences of albuminuria and nephritis will be found, even when the analysis fails to show that such phenomena have no pre-operative existence. Worse than all is the occurrence of uremia and fatal urinary suppression. Fortunately this is rather rare.

It is probable that the danger of bronchitis, pneumonia or pulmonary edema has been much exaggerated. Many cases of respiratory irritation may be attributed to unnecessary and prolonged exposure upon the operating table. Or, what is just as bad, the patient is wheeled without additional blankets from a warm operating room into the corridor, which is much cooler, and then, while reeking with perspiration, is subjected to injudicious ventilation. Shock is another condition that may be properly included among the after-effects. Patients are frequently removed from the operating room clammy and cold and with a sub-normal temperature. Nausea, retching and vomiting may occur at the same time, the anesthetic being a stronger causative factor in the production of these undesirable symptoms than is the clean operative incision. Why, then, is it not reasonable to charge the anesthetic with at least the greater portion of the shock? Nicaise and Porter state that general anesthesia produces shock by interfering with the physiological metabolism, and the general systemic disturbance would seem to indicate that the body tissues are chemically damaged. These points cannot be ignored, even in the face of the fact that shock is usually attributed to the operation.

**After-Care of the Patient.**—The operation completed the removal of the patient from the operating table should be accomplished with as much gentleness as possible. Rough turning, jolting or tossing tends to produce vomiting. The room should be warm, and if the patient show signs of depression he should be surrounded with hot-water bags or bottles and should be placed between blankets instead of sheets. (See Surgical Shock.) The hot-water bottles must always be covered, as they have often caused deep burns while lying in contact with the insensible patient. It is the duty of the administrator to remain by the patient until signs of recovery present themselves, and it is even better to remain till consciousness has returned. Under no circumstances must the patient be left alone until conscious.

Good ventilation, quiet and gentle perspiration, to hasten elimination of the anesthetic, are matters of importance. If the respiration is not free the chin must be watched and lifted forward if necessary. Sometimes the breathing is not interfered with during recovery if the patient is turned upon the side and a little toward the face. This position permits the tongue to fall forward and the mucus and saliva to run freely from the mouth, and should vomiting occur there is no difficulty in keeping the pharynx clear, the ejecta naturally gravitating from the mouth. The

attendant is frequently required to clear the vomited matter from the mouth of the patient lying upon the back.

Usually no nourishment is given by the mouth for four or five hours after the administration, and if nausea and vomiting are persistent and troublesome food may be suspended for days if necessary. Of course in such a case nutrient enemata must be used, e. g.: liquid peptonoids one ounce, milk one ounce, and water one ounce. This may be repeated every three or four hours. Clear soup, milk, beef-tea, broth, whisky and egg, etc., can be used for the same purpose in almost any proportion. It is wise not to give too large a quantity, as it may not be retained. Four ounces is a suitable quantity. If vomiting be persistent patients are usually grateful for small pieces of cracked ice, but the effect on the tongue is undesirable. The epithelium is destroyed and the tongue becomes dry and furred, and taste is temporarily destroyed. Several ounces of hot water may sometimes be given with relief, and the same is true of champagne, ginger ale and hot black coffee.

**MEDICATION.** Although the gastric disturbance following anesthesia is generally self-limited the following remedies are often symptomatically indicated:

*Arsenicum album.* When the patient is adynamic and has great thirst for cold water, which is vomited about as soon as ingested. He is restless and complains of burning in throat or stomach.

*Bryonia alba.* Strange as it may seem this remedy is probably oftener indicated after operation than almost any other. There are headache, dryness in throat and fauces, thirst, vomiting, often general soreness and all symptoms aggravated by motion. The patient dislikes to move because it induces vomiting.

*Ipecac.* Prostration not marked, but nausea is constant, and retching, gagging and vomiting are frequent but afford no relief.

*Nux vomica.* Distressing nausea and a desire to vomit, with the expectation of relief therefrom. Complaint of gas in stomach and bowels.

*Veratrum album.* Great prostration, cold sweat on face and brow. Violent efforts at vomiting. The face is pale and a sensation of fainting may be complained of.

*Tabaccum.* Intense nausea, wretchedly sick and faint, deathly faintness with cold sweat.

Antimonium tartaricum, cuprum arsenicosum, kali bichromicum and iris versicolor will occasionally be useful.

Apomorphia, 3x, for persistent, collapsing vomiting and retching, or the same remedy hypodermically, will also be found a useful agent.



## CHAPTER II.

### CHLOROFORM.

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**Introductory Considerations.**—Chloroform was introduced as an anesthetic by Sir James Y. Simpson in 1847. Its formula is  $\text{CHCl}_3$ ; it is a colorless, volatile fluid, with a rather pleasant odor and sweetish, pungent taste. It may be prepared by distilling dilute alcohol with chloride of lime. Although not inflammable it decomposes in contact with a spirit lamp or gas light. It becomes impure if exposed to light or air, hence it should be kept in tightly-stoppered, colored, glass bottles and procured, preferably, in small quantities.

**Cases in Which Chloroform Is Preferable.**—Chloroform is more generally used for children, although the idea that they have immunity from its dangers must now be abandoned. In matters of anesthesia children cannot usually be reasoned with, and, naturally, that anesthetic is selected which has, for the child, the shortest period of terror. Ordinarily it is employed instead of ether in renal affections, atheroma, asthma, emphysema, bronchial and laryngeal irritation, in the presence of fire, and when the actual cautery has to be used within or near the oral cavity. Many prefer it if the patient be of the florid, obese or full-blooded type. Dyspnea from constricted upper air passages, tympanites, thoracic fixidity and operations in the mouth or pharynx are regarded as suitable cases for chloroform. Some surgeons prefer it also in abdominal surgery on account of the fact that it is attended with less danger of vomiting and rigidity in the abdominal vicinity.

**Contra - Indications.**—The Hyderabad chloroform commission sought to show that chloroform did not directly depress the cardiac action, but the mass of accumulated clinical testimony is responsible for totally opposite views.

In general terms it may be said that chloroform is a greater circulatory depressant than ether; inferentially, therefore, it would be avoided in shock, anemia or cardiac lesions. On account of the muscular flaccidity required in the treatment of dislocations chloroform is usually employed, but several surgeons have called attention to fatalities which have occurred from chloroform anesthesia for the reduction of shoulder luxations. They have suggested the unfavorable position as conducive to the fatal results. And yet the theory has been advanced that the (supposed) safety of chloroform anesthesia in midwifery was on account of its being so frequently administered in the lateral position. It holds the first place in allaying the pains of labor, but, in spite of that, when obstetrical surgery becomes necessary ether is here recommended.

**Administration.**—The patient is prepared as for ether, and the recumbent position insisted upon. Every effort should be made to relieve

apprehension. This is far more important with the administration of chloroform than with ether because fright acts as a decided cardiac depressant and chloroform would enhance it; on the other hand ether would probably counterbalance this because it is so essentially a circulatory stimulant. Kappeler records the case of a man who was prepared for operation and who died upon the table while an assistant pretended to give him

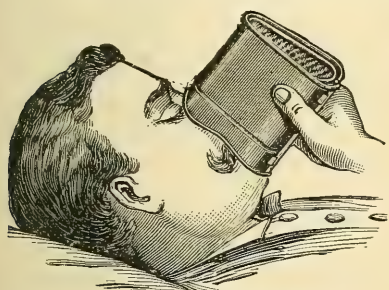


Fig. 13. Allis' Ether Inhaler.

the anesthetic. Simpson reports a death that occurred while the groin was being shaved preparatory to operation. Agnew had a somewhat similar experience. Records are not wanting to show that syncope and fatal circulatory failure have occurred early in the administration of chloroform. Of course some of these may be charged to the same causes that are responsible for those deaths occurring just previous to inhalation, namely, fright and apprehension. Even if this be granted, chloroform cannot be entirely blameless, because similar disasters are almost unknown with ether or nitrous oxide anesthesia, and this would argue in favor of the action of some other influence than fright when the deaths take place early in the administration of chloroform. (Hewitt). This seems quite reasonable when it is remembered that ether is markedly a cardiac stimulant, and that nitrous oxide acts so quickly that apprehension, fright and consciousness vanish before the process of anesthesia can add any terrors to the already overtaxed nervous centers.

Various inhalers are used, but none gives more general satisfaction than Esmarch's. In the absence of this the corner of a towel may be drawn through a safety-pin and a concave mask formed. The mask should not be placed too near the face. It is advised that about an inch of space be allowed between the face and the inhaler, or at least that portion of it upon which the anesthetic is dropped. It is necessary that the vapor should be diluted with air. Never administer chloroform from an ether inhaler. A few drops should be placed upon the inhaler, which is held over both mouth and nose, the patient being instructed to close his eyes. The vapor is irritating if too strong, and if it should drop from the inhaler may act as a vesicant. This may be obviated by smearing a little lanoline or vaseline upon the lips and face. When a large quantity is poured upon the mask it is to be hoped that it is accidental, for such concentrated vapor must be regarded as extremely dangerous. If more is poured on than is required the mask should be held farther away from the

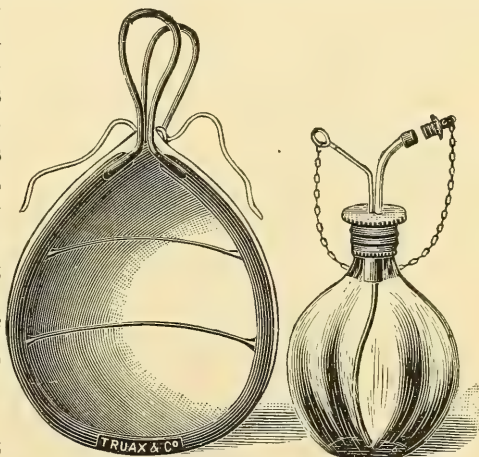


Figure 14. Esmarch's Inhaler.

face so as to allow for dilution. For some reason—or perhaps without reason—the process of chloroform anesthesia has been divided into three stages. As far as the writer's observation goes this is more of a tradition than an actuality. It is quite as easy and reasonable to try to demonstrate that the recovery from anesthesia has three classical stages as to divide the process of its induction into three stages. In the one case the patient passes from a state of consciousness to insensibility, in the other the process is reversed. The variability of the latter is no greater than that of the former.

The vapor of chloroform is much pleasanter to inhale than that of ether, and when given cautiously is not attended with the sense of suffocation, coughing, swallowing or respiratory resistance, seen so frequently with the inhalation of ether.

The average subject passes tranquilly from wakefulness to anesthesia when the anesthetic is properly administered. Highly-strung nervous patients or muscular alcoholics may exhibit various phenomena, as crying, shouting, gesticulating and moaning. If there be a muscular spasm the anesthetist must proceed cautiously; more air and less vapor are generally demanded. It is among these vigorous patients that many fatalities have occurred early in the administration. (See page 109.) Attention has been called to the intermittent administration of chloroform as being more dangerous than its continuous inhalation. There is quite a discrepancy among writers as to this. Regardless of this it is wise for the anesthetist to be guided by the condition of the patient and never hesitate to withdraw the inhaler whenever ominous symptoms manifest themselves. It is believed that it enhances the danger to operate under light chloroform anesthesia, and a proper level of analgesia should be maintained; but it is better to err on the side toward the basis of safety than on the other side of the danger line. The inhalation must proceed carefully, but it may be increasingly continuous till a satisfactory degree of anesthesia is reached and then given, perhaps drop by drop, or according to the indications of a return to sensibility. The recurrence of the lid-reflex, (i. e. the closing of the lid when the conjunctiva is touched) a somewhat dilated, but active pupil, the increased pallor of approaching emesis, and extremely quiet breathing are generally indications for more anesthetic. If emesis is not threatened the color will be less pallid as insensibility decreases and more chloroform is needed. The appearance of the patient differs considerably from that produced by ether. The face is pale, although at the beginning its color may be somewhat heightened. Slight cyanosis may appear and the free ingress of air be interfered with; as, for instance, the pursing of the lips or backward falling of the tongue. The pale face grows even paler as retching or vomiting is threatened. The respirations are tranquil or occasionally softly stertorous. The pulse may be rapid, but most frequently is slow, changing to a running or flickering pulse as complications arise. It may be temporarily accelerated but becomes slower as full anesthesia is reached and consciousness and mental excitement are overpowered. The pupils are moderately contracted—variable, of course—but they can scarcely be gauged till the operation has begun, for sometimes they are quite widely dilated reflexly even during satisfactory narcosis. But in such a case the collective phenomena of collapse are absent. The dilated pupil which will not re-act to light is to be dreaded.



It indicates that collapse is imminent. The vapor must not be administered sufficiently strong to cause the patient to cough or hold the breath.

In from ten to twenty minutes after reaching profound anesthesia the body temperature will be sub-normal, the muscular system be relaxed, the conjunctivæ insensitive, and the eyeballs fixed, or one may be fixed and the other mobile.

Plethoric or obese patients are somewhat prone to stertorous breathing during deep anesthesia and the respiration may be a little hurried or deeper than normal. As under ether narcosis the lower jaw should be kept well forward and pulse, respirations and color of the face carefully watched.

The sub-cutaneous injection of morphia before the administration of chloroform is sometimes advisable. Nussbaum, of Munich, is credited with being the first to publish observations upon the subject in 1863. He, however, injected the morphia during anesthesia with the intention of relieving the after-pains, and succeeded in producing a somewhat prolonged sleep after the operation. Later the drug was injected about twenty minutes before anesthesia was begun with the idea of aiding the chloroform in overcoming sensibility. The result was as expected. The inhalation of the anesthetic was followed by less mental and muscular excitement and much less of the anesthetic was required to maintain a satisfactory level of anesthesia. Such has been the experience of the author. The anesthesia thus produced is quieter, and the tendency to respiratory irregularities and asphyxia less noticeable. In cerebral surgery such a preliminary injection is said by some to diminish vascularity of the brain and its meninges. Mixed narcosis is not here recommended as a routine practice, but there are certain cases in which it may be resorted to with decided advantage. For further consideration of this subject the reader is referred to page 94 et seq.

**Dangers from Chloroform Anesthesia.**—There are various influences which modify the action and, in consequence, the phenomena of chloroform anesthesia. The manner of administration, the condition of the air passages, the nature of the operation, the position of the patient, his general physical status and his susceptibility to the action of the drug are conditions which are quite capable of exerting a modifying influence during the induction and maintenance of anesthesia. Although some advise that the drug be administered freely and continuously the attention of more than one surgical authority has been directed to what may be correctly termed chloroform idiosyncrasy and, bearing this in mind, the anesthetist will avoid reckless freedom in the exhibition of the drug. It must be administered cautiously and in small quantities, in order that the patient's susceptibility may be estimated.

Accidents are more prone to occur among men than among women. This is particularly noticeable among muscular subjects, probably because they require so much more of the drug, and because they are most likely to display a tendency to muscular spasm. And this adds decidedly to the danger, because during a muscular spasm the thorax is fixed, the chloroform vapor is imprisoned within the lungs and rapidly absorbed, especially if the blood be circulating slowly and affording more time for absorption.

Obstruction of the air passages is not so likely to occur during the

administration of chloroform as during the inhalation of ether, for the reason that the tongue is usually less engorged, because chloroform does not produce the same abnormal secretion of mucus and saliva. But the same degree of asphyxia or respiratory embarrassment with chloroform is far more dangerous than with ether. This is because the chloroform heart is already depressed and cannot stand the extra strain levied upon it by the impeded respiration. Careful anesthetists have noticed evidences of circulatory failure even while the respiratory efforts were regular and satisfactory, and therefore such evidences of danger would be overlooked if the respirations alone were relied upon to give signs of pending danger. What has already been said concerning vigilance during etherization applies even more forcibly here. The pupils must be watched as to size and mobility, the countenance as to color, and the pulse and respiration as to time and character. The conjunctivæ should be tested repeatedly for the lid-reflex, and sometimes the patient's anesthetic tolerance may be gauged by observing the muscular tone. Jerking of the arms has been known to precede respiratory cessation.

**RESPIRATORY FAILURE.** From what has previously been said it will be seen that any respiratory embarrassment requires prompt attention. There is not the same tendency to respiratory complications from the administration of chloroform as from the use of ether, but occasionally inhalation of the former anesthetic is attended with stridor or a high-pitched crowing respiration. This is most frequently associated with a light degree of anesthesia and subsides as more chloroform is added. At times it persists during the operation, regardless of a freer use of the anesthetic. Nor does elevation of the jaw or tongue-traction always cause its subsidence, although they should be tried. If it should occur during deep narcosis it will be likely to disappear with the free admission of air. For it is believed that profound anesthesia may lead to a spasm or falling together of the aryteno-epiglottidean folds, in which case air must be admitted freely and the jaw and tongue attended to, as frequently advised. Fortunately this is not of common occurrence, but for all that it must be regarded as important because such a quality of breathing has sometimes been the forerunner of respiratory cessation. Closure of the glottis is by no means an impossibility under chloroform and the finger should be swept over the base of the tongue. In such a case the treatment would be the same as that already recommended for similar complications during etherization.

Another danger to respiration is threatened when chloroform is administered for the performance of an operation under gaslight; that is, the decomposition of the anesthetic. My attention was first attracted to this fact by the constant and annoying coughing and "ahem"-ing of the assistants during a gaslight operation. Then the patient began to breathe badly, and I, too, soon yielded to the persistent and irresistible inclination to cough. This rapidly increased until the throat, bronchial and pulmonary irritation was maddening, when I suddenly came to a vague realization as to the cause of the patient's danger and my own distress, opened windows and doors and hastily terminated the operation. Later investigation of the subject revealed the fact that chloroform vapor is decomposed by the action of gaslight—the products of such decomposition being carbonyl chloride, or phosgene gas, and hydrochloric acid—and that

in some reported cases these were responsible for post-operative pulmonary complications.

**CIRCULATORY FAILURE.** Aside from the toxic influence of chloroform upon the circulatory apparatus there are other conditions that are known to have some effect upon it. Mental emotions have been previously considered under administration. Vomiting may induce cardiac depression and, as it often indicates light anesthesia, it may be relieved by striving for a more profound narcosis. The increased pallor, dilated pupil, shallow respiration and small, weak pulse often bespeak pending emesis, which may be averted by more of the anesthetic.

Here, again, the anesthetist must be cautioned to watch the respiration, for the slightest degree of respiratory embarrassment may promptly produce signs of cardiac failure, as so may excited struggling or the surgical manipulations themselves. When such signs manifest themselves inversion, artificial respiration and cardiac stimulation are in order. (See Cardiac Failure under Ether.)

**After-Effects.**—Nausea and vomiting do not occur so frequently after chloroform as after ether, although some believe that there are cases of post-operative chloroform emesis which are even worse than those succeeding the administration of ether. Fatal cases of vomiting after chloroform narcosis have been reported. While ether vomiting is more frequent it is also more transient. There is also less mucus and saliva secreted during chloroform anesthesia and hence less tendency to coughing and straining during and after its administration.

Bronchial or pulmonary affections are not to be expected from the chloroform per se, but such may occur from exposure during the operation, while being transferred from the operating room or from being subjected to draughts or injudicious ventilation. The nephritis which sometimes follows the administration may be due to the same causes. It was formerly believed that chloroform exerted no deleterious influence upon the renal structures, but of late careful urinary analyses have shown that nephritic irritation and inflammation are by no means rare, though considerably less frequent than may be shown after ether.

The treatment of the after-effects of chloroform is practically the same as for those of ether. (See page 103.)

**A. C. E. Mixture.**—This consists of one part of alcohol, two of chloroform and three of ether.

The objection has been advanced that such mixtures do not volatilize uniformly—that the patient who is supposed to be inhaling the vapor of the different ingredients may be inhaling little except the one which is most capable of endangering life. This objection is said to be overcome by using only a fresh mixture and preparing it from ingredients at a certain specific gravity. It is used in obstetrics, and some recommend it in general surgery when ether alone begets bad breathing. It is administered by means of an open inhaler upon which small quantities are poured from time to time.

Its complications and after-effects are to be managed according to the methods previously described.



### CHAPTER III.

## NITROUS OXIDE AND COCAINE.

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**Introductory.**—It has been an almost universal impression among physicians that nitrous oxide gas was useful only for brief periods of anesthesia. The idea of transitoriness of gas anesthesia is probably due to the fact that its use is confined almost solely to the extraction of teeth, a procedure which necessitates the removal of the inhaler with rapidly returning sensibility, and I have endeavored to find some objections to the renewal of inhalations, but without success. It is simply the custom not to do so. Under the same circumstances ether and chloroform would likewise be transient in their effects, so that the wonder is that gas has not long ago been applied in general surgery.

This anesthetic has scarcely been used sufficiently for prolonged operations to enable us to speak definitely as to its working area in general surgery. One thing is certain, however, and that is that previous teachings to the effect that nitrous oxide could be used only for those brief operations which must be performed in from thirty to sixty seconds must now be regarded as erroneous. As a matter of fact, time has but little influence upon its administration.

While it is not expected that gas will displace ether or chloroform it must be admitted that it ought to take a place somewhere among the anesthetics for general surgery that has not previously been accorded it.

**Properties of Nitrous Oxide.**— $N_2O$ .—It is colorless, slightly sweetish in taste and almost odorless. In fact, patients sometimes scarcely recognize that they are breathing other than atmospheric air. Although its chemical symbol betokens its composition to be of the same gases as the air we breathe it is not a simple mixture of these two gases, but is a definite chemical compound in which the properties of the original gases are lost and new ones peculiar to itself are developed. (Guilford.) Under heavy pressure it is condensed into a transparent liquid, and in this form is quite portable for surgical purposes. The precise manner in which anesthesia is produced by this gas has never been clearly understood. The same is true of ether and chloroform. The process of gas anesthesia has been divided into three stages; namely, exhilaration, excitement and relaxation. It is scarcely possible to differentiate these stages, especially as anesthesia is so rapidly induced. While the time necessary to produce anesthesia varies very much it is estimated that fifty seconds is about the average time. Vigorous, muscular subjects require more time than children or asthenic patients. Consciousness usually returns quite as rapidly, varying from thirty to sixty seconds. The ability to exhibit the gas in full quantity at the beginning without producing distress, the rapidity of its action in overcoming sensibility, and its equally rapid elimination as soon as administration is suspended are features that are peculiarly characteristic of this anesthetic and absent in others. Another fact is that nitrous oxide practically defies the law of stimulation and depression. That law is

that stimulation, whatever its degree, is followed by depression in proportion to the stimulation (exhilaration or exaltation) preceding it. This is a regrettable truth as regards ether or chloroform but can scarcely be said of gas, and hence is removed one of the strongest factors in the production of surgical shock. Its freedom from nausea, vomiting, shock, sweat, frigidity, bronchial and laryngeal irritation, and especially its rapidity of action, give gas the first place as an anesthetic for painful secondary dressings, examinations, etc.

**Relative Danger.**—Squibb has well said that "The line of greatest safety in practice is to regard the difference between anesthesia and death as a difference in degree only." It is conceded by all that nitrous oxide is the safest of all anesthetics. The mortality with the different anesthetics tabulated previously is as follows: Ether, one death in 16,302; chloroform, one death in 3,162; nitrous oxide, practically no deaths—in one office alone, one hundred and forty-seven thousand administrations of gas without one death or any serious result. Deaths have been reported, but I have been unable to find records of more than four since the liquefied gas has been in use. When we consider the thousands—yes, millions—that have been hastily ushered in from their daily walks in life and anesthetized with gas, often by men who are utterly incompetent and nearly always without having in the least prepared the patient, we are surprised that the deaths reported—or even rumored—are so few. Patients are anesthetized under conditions that are most unsurgical. So far as the author's observation goes no preparations are made for complications, although the gas is administered to women whose thoraces are constricted by tightly laced corsets, and to both men and women regardless of the condition of the stomach—whether it be empty or distended with food or gas from flatulent dyspepsia. And as regards the graver lesions it will surely not be contended that these anesthetists are sufficiently drilled in physical diagnosis to seriously consider pathological lesions of the lungs or heart. It was formerly the custom for dentists to manufacture their own gas, and it is not unlikely that much of it was impure. Then, too, some of the deaths attributed to gas were due to other causes, e. g., foreign bodies in the larynx or trachea, post-operative apoplexy, etc. Another thing of importance is the fact that in dentistry anesthetics are administered while the patient is in the sitting posture, which is contrary to the surgical rules of our profession and should testify to nitrous oxide's being a safer anesthetic in general surgery than in dentistry.

**Adaptability.**—As has been taught since the introduction of nitrous oxide it is the anesthetic par excellence for opening abscesses, aspirating, curetting ulcers, slitting up sinuses, making digital examination of irritable rectum or vagina, the evulsion of a toe-nail or finger-nail, etc. It might be asked why this is regarded as the proper anesthetic for these operations? Is it because it produces a better quality of anesthesia? No, but because it produces a quality of anesthesia which answers all practical purposes, and is characterized by a degree of safety which other anesthetics do not possess. If this principle is applicable to short and simple operations it surely ought to apply, with even greater force, to prolonged major operations. The author, while not discarding ether and chloroform, has found gas capable of producing anesthesia of a degree that was quite satisfactory for the performance of such operations as breast

extirpations, laparotomies, hysterectomies, amputations, removal of pile inch, castration, osteotomies, and operations upon the perineum and cervix, etc.

Almost any operation in surgery, except those within the oral or respiratory tract, can be performed under gas anesthesia, whether its performance requires two minutes or two hours, and in nearly all cases the anesthesia is more satisfactory after the first few minutes. It cannot always be relied upon, however, to induce thorough and complete muscular relaxation. Consequently it is not the best anesthetic for use in the examination of joints, displacements, fractures, etc.

Phonation and reflex muscular twitching are sometimes persistent, and, indeed, there are times when they are so persistent under ether that their abolition is attended with danger. There are many operations in which twitching would not be any inconvenience, and, even though it should be a slight inconvenience to the operator it will be fully compensated for by the freedom from after-effects when the anesthetic is suspended. On this account, and because of the shape and size of the inhaler, I would not regard nitrous oxide as the ideal anesthetic in ophthalmic surgery, although I have never seen it tried. As a general rule alcoholics do not take gas kindly. In a few cases where I have anticipated bad anesthetic behavior on the part of the patient I have preceded the administration of the gas by a hypodermic injection of morphia, which had the effect of rendering the anesthesia all that could be desired. Organic disease of the heart, lungs or kidneys seems to offer no special contra-indication to this form of anesthesia. Underwood says: "Organic disease does not involve any additional risk whatever to the patient." Anesthesia is a departure from the normal and any lesion of the vital organs, while it does not contra-indicate the anesthetic, must necessarily augment the departure from the basis of safety.

My own experience with nitrous oxide among children has not been as satisfactory as among adults. This may be due to inaccurately fitting inhalers, or to less experience among children.

**Administration.**—Before the administration of gas I observe all the rules generally laid down for other anesthetics. I make all the usual preparations for complications. Cardiac and respiratory stimulants, tongue-forceps, gag, etc., should always be at hand. The patient should be watched constantly and the conjunctivæ palpated as a measure of insensibility. By watching the face we can prevent asphyxia, which is ushered in by a dull bluish or grayish pallor overspreading the countenance. This is apt to be accompanied by spasmodic or jerky respirations, and sometimes stertor. The first appearance of these changes demands that the amount of gas flowing into the inhaler be diminished, or be wholly suspended for a few seconds. The flow of gas is regulated by the amount of pressure exerted upon the upper portion of the inhaler.

After insensibility ensues the pressure upon the piston may be relaxed when it rises automatically and the patient inspires air. In the majority of patients an occasional inspiration of air may thus be permitted without removing the inhaler. One inspiration of air to ten or fifteen of nitrous oxide is frequently permissible. Or the piston may be pressed to just such a point that any proportion of air may be admitted constantly. Occasionally patients are met who require the constant and



undiluted flow of gas, although it is probable that some air finds ingress at the side of the inhaler.

There is always a bluish tinge to the skin when anesthesia has been secured. This is not unlikely to intimidate a novice. The respirations are somewhat hurried and deeper than normal as the full effect of the

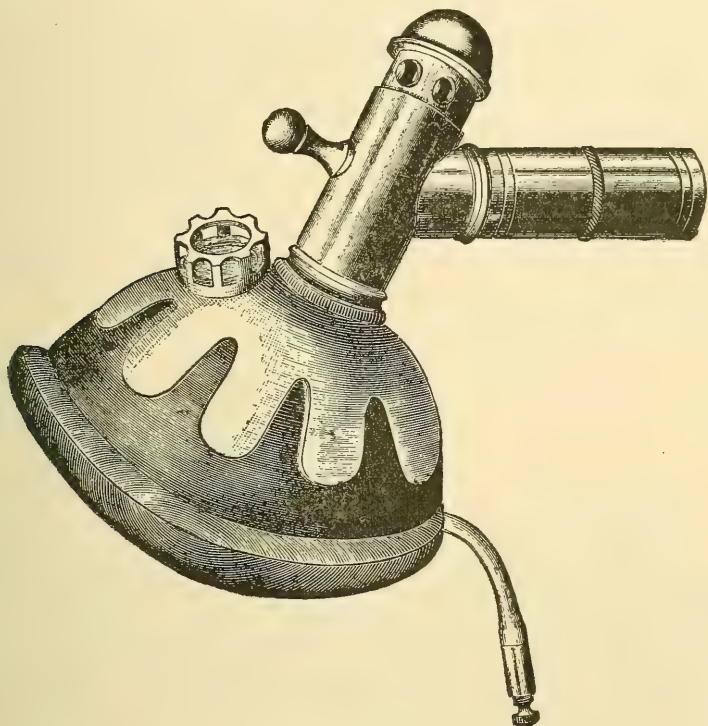


Figure 15. Nitrous Oxide Gas Inhaler.

gas is being obtained. The pupils are variable. In some subjects dilatation supervenes and in others there occurs but little change from the normal. The lid-reflex is generally absent during deep narcosis, but may sometimes persist in conjunction with a satisfactory degree of analgesia. The pulse may at first be accelerated, but usually remains full and strong. In fact it is not infrequently better during the administration than previously. Of course the operator will remember that the arterial blood becomes the same color as the venous, but immediately recognizes one from the other by the character of the bleeding or by the pulsation.

It is believed that cardiac failure is never threatened without disturbance being first manifested through the respirations. The most common complication with gas anesthesia is a tendency to cyanosis and then asphyxia. This need scarcely ever occur in proper subjects with proper administration. It most frequently attends the effort to overcome rigidity, phonation or twitching in bad subjects. If the difficulty to overcome be twitching alone this can sometimes be accomplished by admitting more air through the inhaler. If a patient cannot be satisfactorily controlled with gas continue its administration till a cone or inhaler is saturated with ether or chloroform and quickly substitute one of the latter for the gas inhaler.

It is the best primary anesthetic at our command, but it must be admitted that from the point of economy and convenience it is far inferior to other anesthetics. It is much more tiresome to administer.

The difficulties and accidents attending gas anesthesia are to be treated according to the methods described under ether.

I have noticed but little change in the pulse or pupils; but should either heart or respiratory organs fail the same rules would apply here that are so familiar in similar conditions arising so frequently from ether or chloroform. In the case of gas I should regard artificial respiration as very important.

Only constant watchfulness can give the patient that degree of safety that belongs to him by right of employing a reputable surgeon and entrusting his life in his hands.

As White has said: "Immunity from danger can best be assured only by an intelligent and watchful guard, and the anesthetic should be suspended while yet the centers governing respiration and circulation are not too profoundly impressed."

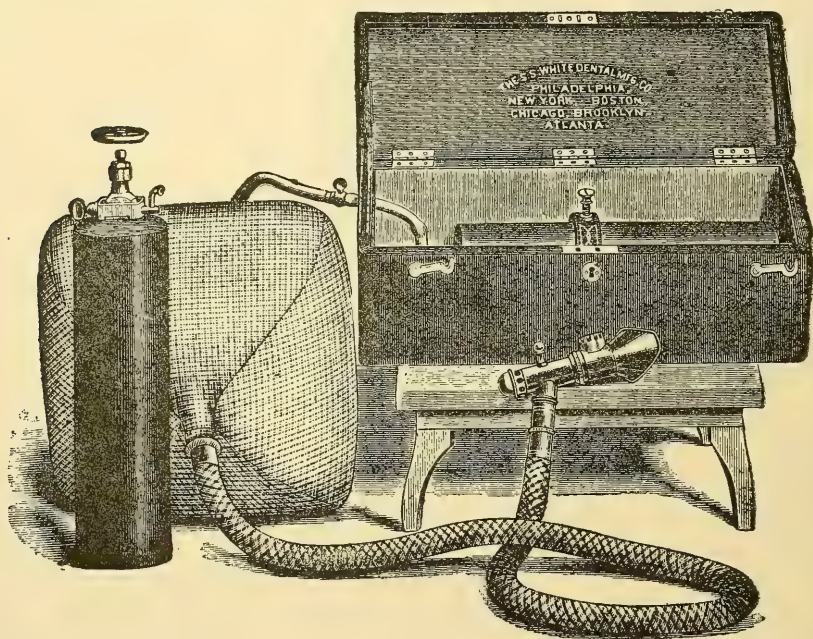


Figure 16. Nitrous Oxide Gas Apparatus.

**After-Effects.**—The condition of patients after gas anesthesia is pleasant to perceive. The eye is bright, the intellect is perfectly clear, the skin natural, pulse scarcely changed—in short, most patients appear as though nothing had happened. Consciousness usually returns in less than a minute. I believe I have never seen vomiting occur when the patient had been properly prepared. One person is reported as having regained consciousness after tooth extraction, was able to walk about the room, and died an hour after from edema of the lungs. Another patient, an old alcoholic, was delirious for hours after operation.



## COCAINE.

**Administration.**—Cocaine hydrochlorate is the most effective local anesthetic. A two to four per cent. solution applied to the mucous membrane or to an abraded surface will induce anesthesia in from two to five minutes. This usually lasts about twenty minutes, although its effect can be prolonged by incarceration. That is to say, when it is injected beneath the skin—say in the finger—a ligature is tied about the finger on the proximal side. This holds the cocaine within the area to be operated and its full effect is thus obtained. If much of the solution has been injected, or the patient is thought to be susceptible, the ligature may be loosened when the operation is completed and then drawn tight again, permitting the cocaine to enter the general circulation in small quantities and thus avoiding its toxic effects. The solution should always be fresh, as it soon decomposes when allowed to stand.

It is perhaps needless to add that sterilized water should be used in preparing the solution and that the hypodermic needle and the skin through which it is to be thrust must be rendered aseptic.

Krogius' method is to inject from fifteen to twenty drops of a two per cent. solution in the neighborhood of the nerve trunk from which the area to be operated derives its nerve supply.

Cocaine anesthesia is quite sufficient for the extirpation of small or superficial tumors, ingrowing toe-nails, removal of foreign bodies, amputation of fingers or toes, circumcision, etc. In certain cases quite extensive operations have been performed with the aid of cocaine. Among them, cystotomies, thoracotomies, laparotomies, etc. In such operations, the solution is first injected sub-cutaneously and then dropped in as the incision is made and deepened.

**Poisoning.**—Cocaine poisoning is usually ushered in with dilated pupils, volubility and dryness of lips and oral mucous membrane. The effort to moisten the lips with the tongue is quite persistent. In some it produces a sense of warmth, well-being and hilarity, in others, tremor, weak pulse, pallor, or even syncope, delirium, convulsions and death.

It is advised that not more than two-thirds of a grain be used on the mucous membrane, and not more than one-third of a grain sub-cutaneously. It is much better to keep below this quantity. The utmost care should be exercised in its application in the region of the head or neck. In these localities it is likely to produce toxic effects. By some, cocaine is regarded as more dangerous than ether.

**TREATMENT.** Mild cases of cocaine poisoning usually subside without any treatment. If there is much weakness, stimulation with brandy or coffee is useful. Nitrite of amyl may be inhaled. Recumbency should be insisted upon. In severe cases the tetanic spasms of the respiratory muscles are frightful to behold, and demand prompt application of chloroform or ether to control them. Cardiac or respiratory stimulation should be employed if necessary, as advised under ether. Chloral, 10 to 15 grains by enema, is recommended. Homeopathically, belladonna, hyoscyamus, strychnia, nux vomica and ignatia are useful.

**Chloroform and Oxygen.**—While these pages are being reviewed, Northrop, Philadelphia, reports a series of successful administrations of chloroform through which oxygen is passed and inhaled during the induction and maintenance of anesthesia. The results have, so far, been satisfactory and very promising. For further study the reader is referred to the *Hahnemannian Monthly* for February, 1895.



## SECTION IV.

# SURGICAL SHOCK.

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**Surgical Considerations.**—Surgically considered, shock is the nervous phenomenon representing the initial systemic effect of local traumatism. It will not be understood by this that shock cannot be produced by psychic as well as traumatic influences. Although psychic shock may be profound it is not necessarily surgical; but the varieties which are the accompaniment of visible trauma, and especially if coincident with or subsequent to surgical procedures, are of special interest.

**Causes.**—Traumatism (with one notable exception, which will be given below) practically includes all the direct causes of shock, surgically considered. It is meant to include all injuries, whether operative or accidental, whether the result of escharotics, burns or scalds, or lightning-stroke, etc. The idea that the degree of shock is in proportion to the extent of the injury received is not always verified. It is more likely that shock is the measure of resistance possessed by certain organs or structures to traumatic influences. A patient may withstand an abdominal section, for instance, and yet be prostrated by an enema. Examples showing that the extent of the injury is not in proportion to the shock might easily be multiplied. Opening a digital abscess has produced death; a slight blow upon the testicle or epigastrium may result in alarming depression of all the vital forces. I have seen simple skin plantation for an ulcer of the leg followed by severe shock, from which the patient did not recover for forty-eight hours.

**PSYCHIC INFLUENCES.** Powerful vulnerating forces are, however, much more prone to produce an alarming degree of shock than if the injury be inflicted by a less forceful influence; e.g., as a rule an injury received in a railroad accident is more likely to be attended by shock than a fall from a bicycle, even though the degree of local traumatism in the latter case equals that of the former. The psychic element in the railroad injury accounts for the difference. This is illustrated by the recorded case of profound collapse resulting from the removal of a man's boot-heel by the wheels of a passing locomotive.

Those who have studied this subject no longer deny that at least functional if not structural changes may be produced by means of such psychic influences. In accidents such as referred to the knees may quake, the hair stand on end, the brain reel, the heart beat tumultuously, the respiratory apparatus stammer and gasp, perspiration ooze from every pore, and the urine be voided or suppressed; in fact, any of the organs may be transiently disturbed or paralyzed. There is no escape,

therefore, from the fact that the mind is a power within our muscular being (Mueller), or that the psychical and physical are practically one, and that the normal status of our grosser structures is more or less dependent upon the mind as well as the great circulatory and respiratory powers. Emphasis is given to this fact in order that the student and operator will appreciate the importance of tranquilizing the patient's mind as much as possible before operating. (See Prophylaxis of Shock.) Functional or organic disturbances known as "railway spine" and "litigation symptoms" which are often grafted upon railway injuries, cannot be considered in this work.

Hemorrhage encourages and intensifies shock, and if the hemorrhage attends an operation or accidental wound it is practically impossible to differentiate the effects of one from the other. The anesthetic, as a causal factor in the production of shock, will be considered under prophylaxis.

**Symptoms.**—The symptoms are variable, depending upon the character of the injury, the variety of tissue injured, the patient's temperament, atmospheric temperature, and whether complicated by hemorrhage, etc. Shock may vary in degree from a slight and transient depression to the most profound disturbance or even cessation of the vital powers. The face is blanched and shrunken, the nostrils pinched, the lips are colorless, the eyes are dull, the pupils dilated and immobile or sluggish; the respiration is faint and sighing, or at times quick and shallow; the pulse is small, rapid, irregular or absent; the heart sounds are muffled, or even inaudible; the temperature is usually sub-normal. The skin is usually cold and clammy. The patient is often reeking with perspiration; in extreme cases the ears and supra-sternal notch may be filled with perspiration that oozes in great beads from the general cutaneous surface. The extremities are cold, especially the feet and knees. Although the patient is conscious, but little interest is manifested in what takes place around him. He may answer questions in monosyllables and then relapse into indifference. Of course cerebation may be impaired or destroyed if the head be the seat of the injury. Relaxation of the sphincters and involuntary urination and defecation will sometimes occur. Occasionally vomiting is an accompaniment, but may sometimes be indicative of reaction. Hiccough, associated with shock, may usually be regarded as an ominous symptom.

The proneness of intestinal lesions to produce shock is worthy of attention, and so is the deception in its manifestations, especially during the period preceding dissolution. It is characterized by cessation of pain and sometimes vomiting, both of which may have been persistent, the patient becomes perfectly rational and the temperature may be normal. This is augural of collapse which is precipitated by operation.

A variety of shock occasionally met with is that known as "prostration with excitement." (Travers.) In this variety the patient tosses wildly, the respirations are quick and shallow, the pulse may be lost or flickering, the skin cold and clammy. Although the patient may make no definite complaint nor specify any locality or source of pain yet the face is expressive of indescribable anguish.

**Diagnosis.**—The diagnosis is obvious. The essential characteristic of shock is "lifelessness." There is no more tragic scene in human life than sudden collapse on the operating table. To feel that one's hand has

shortened the life of a patient, even though doomed by some pre-existing disease, is a horribly unwelcome sensation.

Both the cerebro-spinal and the great sympathetic nervous systems seem to be staggered as by a sudden and terrific blow. The student will recognize it the first time it is seen, and after that it will never be forgotten.

**Pathology.**—Beyond the fact that a damaging impression has been made upon the nervous system producing paresis of the circulatory apparatus little is known of the pathology of shock. It is known that, peripherally, the capillary resistance is diminished; so, too, is the motive power of the heart. If the vaso-motor supply be cut off from one portion of the body the vessels therein dilate, in a few days recovering their tone, although future contraction and expansion are dependent upon local stimuli. In shock the abdominal vessels may or may not be dilated. Further than this everything at present lies beyond the range of human perception. It may be said that in shock there is a disturbance of the molecular equilibrium, that the nerve centers no longer liberate force; but this is of little satisfaction to the analytical mind. The post-mortem findings are negative and throw no light upon the subject. The clinical phenomena, however, corroborate the theory of vaso-motor paresis and the consequent relaxed vascular system. It is borne out especially by the intense thirst and the incredible quantities of fluids that some shocked patients drink; and it is further corroborated by the beneficial effects of intra-vascular or intra-cellular infusion.

**Prophylaxis.**—While we regret that with our present knowledge we are unable to give the rationale of the phenomena of surgical shock, the great and absorbing question should be its prevention. The preparation of the patient for a state of invalidism is all important. Whenever possible the patient should rest in bed for twenty-four hours before operation and be otherwise prepared as advised under preparation for ether, (which see). The pre-operative administration of five to ten drops of tincture of digitalis, or 1-100 to 1-60 grain of strychnia sulphate, may be advisable if danger is anticipated from impaired circulatory apparatus. It should be a part of our professional ritual to operate in the morning when possible. Of course there are lesions that can wait neither for preparatory treatment nor the morning hours; but in the writer's experience this is just the class most prone to shock, and consequently emphasizes the importance of the above observations when they can be carried out. Tranquelize the patient's mind, as before anesthesia.

Attention to the following points will do much toward obviating shock from operation: Time, temperature, degree of anesthesia, and hemorrhage. (Gay.) Since pain has been eliminated from operative surgery by means of anesthesia the idea has been advanced by some that the amount of time consumed in the performance of an operation is a matter of indifference. This is a grave error. I believe there is no means by which so much can be accomplished in preventing shock as by rapid operating. We should remember that upon the operating table it is often impossible to differentiate traumatic shock from the toxic effects of the anesthetic; that this period is usually characterized by sub-normal temperature; that beyond a certain point every inhalation decreases the vital forces; that at best operative insensibility means the establishment of a



tendency toward death, and that the culmination of this tendency may occur during one single minute which is unnecessarily added to the time of operation. This thought should underlie all our surgical procedures and lead to the most careful attention to pre-operative arrangements. I would not be understood as desiring to sacrifice methods, good methods, for rapidity, but as urging better methods in order that the operative period may be reduced, and with it the tendency to shock.

In discussing anesthesia the fact that patients are often unnecessarily deluged with the anesthetic has already been referred to. In cases where shock is anticipated only the smallest possible quantity of the anesthetic should be administered. It is sometimes surprising to note the minimum quantity necessary to produce surgical tolerance. This is especially true if one-eighth or one-sixth of a grain of morphia be injected hypodermically twenty minutes before administering the anesthetic.

Inasmuch as hemorrhage augments shock, or may per se give rise to a condition not distinguishable from shock, the most careful hemostasis should be observed.

The body temperature of the patient may be maintained by means of hot water bags or bottles applied during the operation. The body and limbs should be wrapped in woolen blankets and only the operative field exposed. The irrigation-fluid should be kept quite warm. The temperature of the operating-room should never be below seventy-five, and some believe that a temperature of eighty-five is still better.

In shock from accidental traumatism no operation should be performed till re-action supervenes. This is the rule, but in exceptional cases, as, for instance, the continuous irritation and pain of a crushed and dangling limb, or the presence of a foreign body, operation may be necessary to prevent further shock from these removable causes. Usually, however, it is better to check the hemorrhage, apply sterilizing compresses to the traumatized area, stimulate, await reaction, and then operate.

**Treatment.**—Inasmuch as the toxic effects of the anesthetic, and consequent collapse upon the operating table, are often indistinguishable from true surgical shock the reader should peruse *Managements of Difficulties and Accidents during Anesthesia*. (Page 100 et seq.)

**RECAPITULATION.** To recapitulate briefly; in collapse, or shock, put the patient in a warm bed in a warm room just as quickly as possible. If the clothing is wet, as it often is during and after operation, cut or tear it and remove it quickly and wrap the patient temporarily in hot blankets, among which a number of hot water bags or bottles are placed. Too much care cannot be exercised with this last measure, because patients are thus frequently burned. The bottles should be covered and even then the covering of the bottle must not lie in contact with the skin. In the meantime ten drops of digitalis tincture, 1-60 grain of strychnia, 1-6 grain of morphia and atropia, or 1-100 grain of nitro-glycerine, should be administered hypodermically. If necessary inversion, artificial respiration and anal stretching will be resorted to, according as the onset of the shock is sudden and profound or gradual. If not due to ether, brandy or whisky may be injected freely. Some advise placing the patient in a hot bath, say at 90 degrees, and adding more hot water till the temperature of the water is raised to 110 degrees. Or, an easier way to raise the body heat is to conduct the heat from the flame of an alcohol lamp through a bent

sheet-iron or tin pipe, one end of which lies beneath the bed clothing, the other overhanging the alcohol lamp. Rectal injections of hot fluids are useful. They may consist of plain hot water, hot milk, beef tea, peptonized milk, brandy and milk (an ounce to a pint), or liquid peptonoids in milk or water. In my experience, however, hot, strong black coffee is better than any of the aforementioned to tide the patient over the dangers of the hour. From a half pint to a pint, or more, may be injected and repeated whenever necessary. If the patient is quite weak it should be held in by pressure upon the anus. All fluids thus injected should be as hot as can be tolerated by the mucous membrane, e. g., 110 degrees. The shocked patient requires heat. The attendant should remember that enemata are best administered through a catheter or rectal tube. If the patient is not nauseated the hot fluids may be given by the gastric route.

The skin may be subjected to friction by hand rubbing, but the patient must not be exposed to cold air. The extremities may be elevated or snugly bandaged. Aromatic spirits of ammonia may be given by inhalation and so may oxygen, if procurable. A very important procedure is intra-vascular saline infusion. This is generally accomplished by opening one of the median veins of the arm or the internal saphena as it crosses the malleolus. Sometimes the vessels are collapsed and difficult to find. Pressure above the point of incision will aid in distending the veins of the arm; or the leg may be allowed to hang over the edge of the bed, when the vein may be more easily found. Sometimes it may be necessary to open the femoral vein, or, in extreme cases, the artery. Again, the solution may be injected through a large hypodermic needle into the loose cellular tissue of the abdominal wall or inner surface of the thighs (intra-cellular injection). If a vein is to be opened the overlying skin is incised longitudinally, the vein exposed and ligated at the distal angle of the incision. The ligature may be left long and the vessel lifted and another ligature passed beneath it at the proximal angle of the wound. The vein is slit carefully, the canula introduced and may be tied in by means of the second ligature. No special apparatus is necessary.

The fluid consists of a teaspoonful of common table salt to a pint of hot water. If distilled water is obtainable it should be used; if not ordinary boiled water will answer. The temperature of the solution may range from 100 degrees to 115 degrees. It should be allowed to flow into the vein slowly, e. g., from a pint to a quart in fifteen minutes and much slower in the artery. The improved color of the face and the slower and fuller pulse usually denote the effect of the injection. When such improvement becomes decided the flow may be stopped and the canula left in the vessel, as it may be necessary to repeat the injection. Usually from one to three pints will be required, and can be repeated as soon as the pulse begins to fail. It is important to stop the flow as soon as the pulse wave shows material improvement, because the pulse will usually improve for some time after the injection is discontinued. Unless this admonition is heeded, and especially if the flow is rapid, the face of the patient becomes plethoric, besotted, swollen and turgid, the lips thickened and heavy, the breathing sluggish or stertorous, the pupils unequally contracted, and cerebration suspended. I have seen the casual observer diagnose such a case as cerebral hemorrhage. The condition soon passes away as the system gradually accommodates itself to the sudden influx of

a large quantity of fluid. It is not impossible that cerebral engorgement and pressure may be produced unless a reasonable degree of care be exercised in the injection of the fluid.

**MEDICINES.** In post-operative shock we find a place for our homeopathic remedies, though the general treatment previously laid down should never be omitted in severe cases. This is advised for the reason that in the worst cases deglutition is embarrassed and the vitality is so low that the stomach is inactive and no results can be obtained by the gastric route.

*Camphor.* In the experience of the writer camphor is the most valuable remedy that we possess for shock. Unless there are special indications for some other drug this should be administered. It is indicated by the prostration, anguish, diarrhea, feeble and sighing respiration and cold and clammy skin. It may be given in drop doses of the tincture every five to fifteen minutes; or a teaspoonful of the third dilution in one-half glass of water, teaspoonful doses administered every ten minutes, is quite efficacious.

*Veratrum album.* Indicated by usual shock symptoms, but with the cold sweat confined chiefly to forehead and face. The patient seems nervous enough to fly. May complain of numbness, coldness and tingling of extremities.

*China.* It is especially useful after exhausting hemorrhages. Fainting, ringing in the ears, deafness, difficult breathing and eructation are symptoms for china.

*Arsenicum album.* Especially for the variety known as Traver's prostration, with excitement. Thirst, restlessness and adynamia are marked.

These are the most useful, but *carbo vegetabilis*, *tabaccum*, *cuprum*, *arnica* and *nux vomica* will occasionally be called for.

*Staphysagria* is especially indicated in shock following upon operations in the abdomen. While *hypericum* is a remedy of the first importance in shock from injuries to or from operations upon the nerves, *pulsatilla* and *clematis* should not be overlooked when the cause of shock lies in injuries to or diseases of the ovaries or testicles.



## SECTION V.

### ANTISEPSIS.

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**Historical Synopsis.**—Less than twenty-three years ago antiseptic surgery and the brilliant achievements founded upon its basal principles were undreamed of, and these few years since its conception and promulgation by Lister, whom it has immortalized, have seen greater surgical triumphs and more advancement than were witnessed by previous centuries—with the possible exception of the discovery of anesthetics.

The course pursued by operative and accidental wounds during the pre-Listerian days now seems barbaric, and unless the beginner is told of it he can never appreciate it; for it has become a thing of the past. Before the inauguration of antiseptics Lister's death-rate was over forty-five per cent. in general operative work. His antiseptics, crude as it was at that time, at once lowered the death-rate to fifteen per cent. In some hospitals eighty per cent. of all open wounds were attacked with gangrene. Erysipelas and abscesses were on all sides; wounds were not expected to heal without suppuration—surgeons were thankful if they healed at all. Nearly every wound, dressing and draw-sheet was foul with pus, and there was rejoicing if it were the now obsolete "laudable pus" and the wounds escaped invasion by maggots. This represented the power and wisdom of the surgical minds of that day.

The mortality from compound fractures ranged from forty to fifty per cent. Upon the introduction of Lister's methods among the various hospitals whence these statistics were compiled the death-rate immediately fell to four per cent. Now the majority of surgeons throughout the civilized world have adopted antiseptics and one and another have added to the perfection of its technique till the death-rate, with many of our operators, has been reduced to one-half of one per cent. in major operations. Stated briefly, the principle upon which antiseptics is based is the bacteriological causation of fermentation and decomposition of animal tissue, which constitutes the process of wound infection with its resulting complications of inflammation, suppuration, erysipelas, septicemia, pyemia, etc. Diatheses were formerly held as responsible for the production of wound suppuration. Tuberculosis, syphilis, alcoholism, etc., were supposed to have the power to produce pus. This belief has scarcely any supporters at the present time; for the modern methods of wound treatment have enabled us to operate upon such subjects with a reasonable expectation of an uncomplicated after-course. The most that can be said for such conditions is that they are lacking in the normal power of resistance to pus-forming micro-organisms.

Diabetes offers an illustration still more striking than the conditions just mentioned.

Controversy regarding the principles involved in the application of antiseptics seems to have died out and the central theme of discussion at the present time seems to be the selection of the best method for putting the same principles into practice.

**Surgical Technique.**—In considering the surgical technique most in vogue it may be divided thus: 1—Preparation of the patient. 2—Preparation of operator, assistants, instruments, etc. 3—The operation. 4—The after-treatment.

**PREPARATION OF THE PATIENT.** It should be the rule to give the patient a full bath the day before operation, after which the operative field should be thoroughly scrubbed with brush and soapsuds or sapoviridis. This should be done vigorously, because it is practically impossible to sterilize the skin till it is freed of its oily excretion. Shaving with a keen razor is the next step, which is valuable, not only in removing hairs but much dirt and epithelial debris. After this the operative area, and for a considerable distance beyond it, is covered with a compress saturated with bichloride of mercury solution, one to 1,000 or one to 2,000. This is covered with oil-silk and is changed on the morning of the operation. Instead of the bichloride compress some use a soft soap poultice which is efficient in cleansing the skin. The skin should be again scrubbed with a sterilized brush and bichloride (one to 1,000) or carbolic acid solution (one to twenty) just previous to operation. The same surface may be scrubbed with ether to aid in dissolving the oil globules. In the meantime, the site of the operation has been surrounded by mackintoshes which, in turn, are covered with towels rung from a mercurial solution. These are to be changed from time to time as they become soiled and cold. If the operation is to be intra-vaginal, douches of mercurial solution (one to 3,000) or boric acid (three per cent. solution) should be used. If intra-vesical, Thiersch's or boric acid solutions may be used freely. The formula for Thiersch's is salicylic acid, gr. ij, boric acid grs. xij, hot aqua destil. 1 litre. If the mouth is the site of operation it may be previously cleansed with hydrogen peroxide.

**PREPARATION OF OPERATOR AND ASSISTANTS.** Neither surgeon nor assistants should attend an autopsy or handle septic cases previous to operation. The writer's rule in hospital and private practice is to operate the non-infected cases first, and then attend, if necessary, to septic cases afterward.

The surgeon should remove his outer clothing, don a long, clean, short-sleeved gown, remove all finger-rings, and then begin the cleansing of his hands and forearms. The greatest menace to the perfection of operative wound progress is the surgeon's hands. They may be cleansed by a thorough scrubbing in hot water and soapsuds for some minutes. The brushes or nail-cleaner, of whatever variety, used for this purpose should be kept in a mercuric solution, or sterilized by boiling before use. The brush must be vigorously used beneath and around the finger nails and the water changed several times. After this rigid mechanical cleansing the hands are to be immersed for a minute or more in alcohol, and finally in a one to 1,000 mercurial solution for three minutes.

Another method, less in vogue and more irritating to the surgeon's

hands, is to wash as before, with soap and brush, and then immerse in a warm solution of permanganate of potash for two minutes, then decolorize in a warm saturated solution of oxalic acid. They are soaked again in bichloride of mercury solution before the operation is begun. This method is effective in destroying the micro-organisms upon the hands, but is sufficiently irritating to prevent many surgeons from employing it. One of these methods, or some other that may answer the same purpose, will be resorted to by the operator, his assistants and nurses; and after the hands are thus rendered aseptic neither chief nor aids must touch any object which has not been rendered surgically clean without again washing their hands. And in surgery every object, such as a chair, door-knob, the clothing, the pocket, beard, scalp, cans, jars, bottles, etc., are unclean, and the hands which come in contact with them are capable of infecting a wound. In hospital work, where assistants and nurses are plentiful, one of the number is detailed to hand cans, jars, etc., and such a one is regarded as "unclean." Such a nurse does not touch the dressings, but opens the jars or bottles containing them, and they are removed by the clean hands of the assistant or operator. If it becomes necessary for the latter to take these objects he does so after clean hands have wrapped them in a sterilized towel.

Nothing so taxes the surgical discipline as this necessity for keeping the hands aseptic after they have once been rendered so. Everything that has been said in reference to the operator's hands and clothing applies with equal force to assistants and nurses.

**INSTRUMENTS.** All instruments are to be boiled for ten minutes or more in one per cent. solution of carbonate of sodium (or ordinary baking soda will do) and are kept immersed in a similar solution during the operation. Heat is our most effective disinfectant, and moist heat has been found to be more efficacious than dry heat. Boiling is better than baking or steaming, although the latter does very well for instruments, towels, wipers, dressings, and some forms of sutures, etc. Much of the danger from instruments can be removed if they are properly cared for after operation. They should be scrubbed in soap and water, then boiled, dried and laid away. Of course the cleansing is facilitated if all forceps, dilators, clamps, scissors, etc., are separable. The old-fashioned hinge-joint instrument should be interdicted.

**The Operation.**—Naturally the cleanest room available will be selected for the operation, and unless there is ample time no effort should be made to cleanse it. It is wiser to cover the carpet with cheap white muslin or clean sheets which will prevent the raising of dust. Although surgeons have but little fear now of the atmosphere contaminating a wound, it is preferable that all efforts at dusting and cleaning the room should precede the operation by some hours. This allows time for the dust to settle. These remarks apply particularly to operations in private practice where perhaps an ordinary kitchen-table is used as an operating table. This and other pieces of furniture may be covered with clean or sterilized sheets or towels. The dishes for instruments, etc., should be of glass, agate, or porcelain ware, and be thoroughly washed with hot water, soap and brush, then with bichloride solution, 1-500, and rinsed with hot water. The surgeon is saved much time and fatigue if the nurse is sent the preceding day with printed instructions as to the various



preparatory steps. The constitutional treatment, such as moving the bowels, etc., will, of course, be carried out, as recommended, before the administration of anesthetics.

The great surgical desideratum is the primary healing of wounds and its usual accompaniment—a non-febrile after-course; and that this is determined by the perfection and consistency of the antiseptic technique is now admitted by the most advanced surgeons. Years of careful and conscientious clinical observation have made it evident that success has been obtained in the greatest number of cases by compliance with the demands of consistency after the foregoing careful preparation. How often operative behavior, otherwise good, may be seen marred by carelessness or ignorance on the part of one or more members of the corps! For instance; a nurse who is handling the sponges steps across the operating room and closes the door with her hands, and then, without washing them, hands an instrument or sponge to the operator who is to bring them in contact with the freshly cut wound. The nurse does not stop to think that the hand which previous to her own turned the door-knob might have been smeared with fetid pus or rectal or vaginal discharges—though it is by no means necessary that such conditions obtain in order to render it possible that such a thoughtless nurse may contaminate a wound. The novice must always be watched, otherwise an instrument, wiper or ligature may be dropped and placed, without cleaning, in contact with the wound. No hand, instrument, sponge, wiper, ligature, suture or dressing, must touch the wound unless surgically clean. And in order to keep them clean in this sense they must be rendered sterile every time they come in contact with any object or person not clean—surgically speaking.

Some surgeons, either from their physical exertions or from feeling keenly their responsibility for a human life, perspire freely while operating; and though such an operator be beyond reproach as to his personal cleanliness he is reprehensible if he allows the perspiration to drip into the wound or upon anything that touches it. He must immerse his hands frequently and a nurse or assistant must wipe the drops of perspiration from the face and brow. It must be borne in mind that there is a vast difference between social cleanliness and surgical cleanliness, and consequently the onlooker must never be invited or permitted to examine the wound or its site with his fingers till they have been cleaned surgically. More than one spectator may take umbrage at such insistence and tell the surgeon that fingers are cleaner than the patient's rectum or vagina, or a pre-existing suppurating lesion. They do not realize the evils of mixed infection, and that even in the already suppurating lesion they may reinfect with a more virulent form of bacteria. The old-time warning against the opening of "cold abscesses" or tubercular abscesses had its foundation—unwittingly—on this principle. It was not the evacuation of tubercular pus which caused the subsequent aggravation, but the invasion of the wound by more active suppurative influences—the yellow staphylococcus, for instance. Or, the system may be able to cope successfully with the number of bacteria within the lesion, but when dirty surgery or meddling assistance introduces more the systemic resistance may be overcome and irreparable injury done. Numerous experimental inoculations have shown that a given number of pathogenic micro-

organisms can be injected without producing either local destruction or constitutional disturbance, but one or both of these conditions obtain when the quantity injected is increased.

**IRRIGATION.** While bichloride of mercury may be used as strong as 1 to 1000 upon external surfaces it should be used in a weaker solution for irrigating an open wound—1 to 3000 or 5000 being quite strong enough. Some writers claim that even this strength irritates the tissues and impairs their vitality. Whether this be true or not, many surgeons employ such irrigation freely during the operation, as much for the mechanical cleansing of the wound as for its germicidal effect. It is less in vogue, however, since the fear of atmospheric contamination of wounds has decreased. The claim has been made that such irrigation provokes an undesirable amount of post-operative discharge from the wound—especially if carbolized solution has been used. It is not unlikely that the serous discharge from a fresh wound is a functional product, that it is nature's method of irrigation, and that it does no harm unless it accumulates within the wound, destroying coaptation and providing pabulum for infective bacteria. This may be obviated if, in large and deep wounds, all "dead spaces" are obliterated, perfect coaptation secured, and temporary provision made for drainage. In suppurating wounds and pus cavities irrigation is used more than in clean operative wounds. Instead of irrigation frequent sponging or wiping with sterile gauze may be resorted to. Irrigator nozzles should always be sterilized before the operation, as the nozzle may have been pushed into a pus cavity during a preceding operation.

**DRAINAGE.** If the wound is inflicted through clean and non-suppurative tissues, if the operative technique is above suspicion, if the wound is not very large or deep, if perfect hemostasis, coaptation, with subsequent dressing-pressure and immobility can be obtained the surgeon need make no provision for drainage. If the above requirements cannot be complied with drainage is advisable. Per se the large wound is in no more danger than the small one—except that the larger exudes more serum and blood, which are food for invading bacteria. They should, therefore, be removed as rapidly as secreted. For this purpose a sterile tube (rubber, glass or decalcified bone, etc.) is carried into the deepest portion of the wound, brought out at its lowest portion, secured with a clean safety-pin or cuticular stitch, and then cut off flush with the skin surface. A strip of gauze, several pieces of silk-worm suture, sheepgut or horse-hair, may be introduced instead of a tube, although the latter provides the better egress for pus. Sometimes the omission of a stitch in the lower angle of the wound is all that is necessary. In non-suppurating

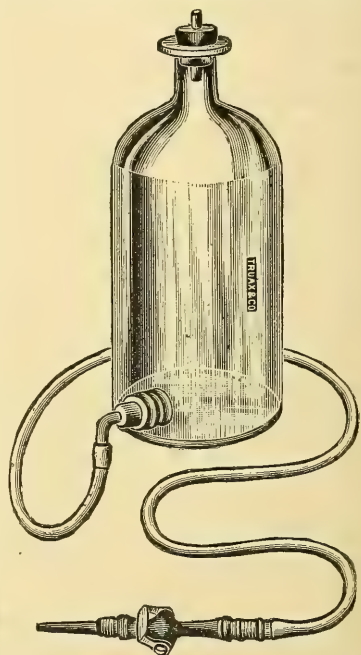


Figure 17. Irrigating Flask.

cases all these forms of drainage may be dispensed with in forty-eight hours; for it is during this period that wound excretion is most profuse. The question of drainage has evoked much discussion, and in general terms it may be said that the necessity for drainage has decreased in proportion to the improvement in the technique of wound treatment. The subject of special drainage is omitted here, and will be found in regional surgery—pelvic, thoracic, abdominal, etc.

**SUTURES AND LIGATURES.** In applying sutures and ligatures, the same care will be observed as with hands and instruments. If silk is used, the needle may be threaded and boiled, or steamed with the instruments. Sheepgut (which for some reason has been called catgut) or the silk-worm suture will be taken directly from the solutions in which they are preserved. The fewer ligatures left in a wound the better. Torsion, pressure, hot irrigation, etc., will often suffice to produce hemostasis. The choice of sutures generally lies between sheepgut, silk and silk-worm suture. The latter is rapidly displacing silver wire, which was formerly so much in vogue. The running sub-cuticular stitch of silk is also gaining favor, and has the advantage in lessened liability to stitch-abscesses, because it lies beneath the skin surface. The other forms of sutures which pierce the skin are more likely to be attended by stitch-abscesses, especially if too much tension is applied, thus diminishing the vitality of the tissues and forming the *locus minoris resistentiæ* of the classical pathologists. In the introduction of any of these sutures the slack portion will be held by the clean hand of an assistant and not allowed to fall in contact with soiled portions of the patient, the clothing, etc.

**DRESSINGS.** After the wound surface and the cutaneous surface for some distance around it have been thoroughly cleansed the dressings will be applied. The wound may first be dusted with iodoform, although this is not used as much as in former years. Next, a plentiful supply of iodoform gauze or plain sterilized gauze, taken directly from the sterilizer, is applied; over this, sublimate gauze, absorbent cotton and gauze or muslin bandages. The dressings may be varied much. Sometimes Lister's protective is soaked for an hour in mercurial or carbolic acid solution and applied to the wound after being perforated or slit to permit of the wound excretion penetrating it and being taken up by the gauze. In this way the dressing is prevented from sticking to the wound and subsequent removal is facilitated. Again, the protective or oil-silk may be placed between the gauze and cotton or outside the cotton, where it serves to distribute the discharges through the dressings instead of permitting them to soak through merely at one point, soiling the patient's clothing and bed, and providing ingress for bacteria. Some advocate perfectly dry dressings, others apply gauze wrung from a mercurial solution. Properly carried out both methods are followed by good results. The objects to be obtained by a suitable dressing properly applied are absorption of discharges, pressure, immobilization and protection. Anything which covers the wound protects it from mechanical injury; anything which absorbs the discharges extracts from the wound what would otherwise be food for invading bacteria. Pressure diminishes the oozing, and immobilization is essential in obtaining the greatest degree of union in the shortest time. Wood-wool, jute, oakum, sterilized sponges, etc., all have their advocates; but it is needless to enumerate the many



substances used for dressings. The tendency of the times is toward simplification, not complication. In dressing the wound no hands except those surgically clean must handle or apply the substance placed over the wound. The primary dressing must consist of a large quantity of absorbent material on account of the profuse discharge which usually follows the operation.

**After-Treatment.**—The subsequent treatment and dressing of the wound will be conducted upon the same principles which determine the surgeon's behavior during the operation. If non-absorbable drains have been left in the wound they will necessitate early dressing, usually within forty-eight hours from the time of operation. But for this the ideal wound may often be allowed to heal without a second dressing. If, then, the wound has been inflicted through healthy structures, if drainage has been omitted, if there be little or no pain or rise in temperature, if the dressings remain in place and are odorless it is meddling surgery to expose the wound. Next to the temperature there is probably no better guide as to the necessity for changing the dressing than the odor. The careful surgeon should develop his sense of smell till it is an invaluable aid in this matter. The character of the odor which informs him that the wound must be exposed is not capable of surgical translation, it is a matter of acquirement.

If sufficient absorbent material has been applied the discharges should not soak through, but when this threatens more dressings may be immediately placed over that already applied. When it becomes necessary to remove the dressings the hands, necessary instruments and dressings should be cleansed as before the operation.

The limb or wounded part should be brought as close to the edge of the bed or table as possible, a mackintosh or Kelly pad placed beneath, and towels placed around the affected area. The surgeon should see that all dressings and everything necessary are within reach before the wound is exposed. The nurse or assistant removes the outer dressings down to the gauze which lies in contact with the wound. Or, if the surgeon does it all, he should re-wash his hands as he reaches the wound. If union has occurred he merely cleanses the wound and the surrounding surface with sterile wipers and applies fresh dressings, in much smaller quantity than at first. Stitches are removed after the surface through which they pass has been wiped or irrigated. The suture is

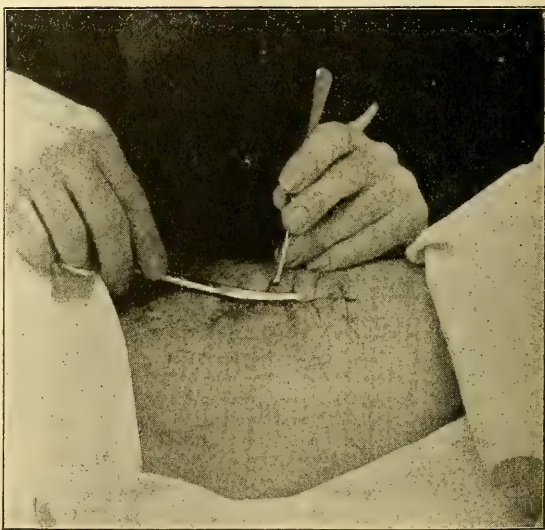


Figure 18. Removal of Sutures.

through which they pass has been wiped or irrigated. The suture is

carefully picked up with forceps near the point of its entrance or emergence, and is slightly drawn out of the skin. Accompanying this one blade of a rather pointed curved scissors is gently insinuated beneath the stitch-loop and the other point of the blade just outside the stitch. Then the blades are made to cut through the clean portion of the suture as it is withdrawn slightly from the skin. This end immediately disappears beneath the skin surface as traction is exerted by the forceps. In this way none of the suture which is foul from having lain upon the outside of the skin is retracted through the wound. If it be found necessary to make much traction on the suture it should be made toward the line of coaptation; otherwise the line of union, being new and weak, may be pulled apart. If the wound be large, as for instance after breast extirpation, laparotomy or thigh amputation, all the sutures should not be removed at once. Some may be removed at the end of a week, others may remain for two weeks, or according to the degree of tension on the flaps and the consequent danger of retraction. If the drainage tube is to be removed it will be irrigated thoroughly and then withdrawn with a slight revolving motion, after which its track is washed out with such solutions as peroxide of hydrogen, boric acid, mercurial or Thiersch's solutions, etc. If the tube is allowed to remain it should be turned gently each time the wound is dressed, because the granulations penetrate and occlude the perforations in the tube. Occasionally a stitch-abscess will be found, consisting usually of two or three drops of pus. These are supposed to be caused by the staphylococcus epidermis albus, which is not very active itself but may lead to more virulent infection when joined by the streptococcus pyogenes. These stitch-hole-abscesses will nearly always be found to accompany the suture which has been drawn and tied with the most tension. Such tension lessens the vitality of the tissues, which are then attacked by micro-organisms. The line of incision and the other sutures may not have the least redness about them, but the stitch of high tension with its little abscess is surrounded by a small zone of inflammation, which seems to exemplify Sutton's statement that "Inflammation is the method by which an organism attempts to render inert noxious elements introduced from without or arising from within it."

Frequently the operation and mayhap the first and second dressing may evoke no wound complication whatever, and the surgeon, feeling secure, relaxes in his attention to detail, or, what is far more common, entrusts the next dressing to the assistant or nurse and finds to his chagrin when the wound is again opened that suppuration has occurred. There can be no doubt at the present day that wound inflammation and suppuration are the essential productions of bacteria, pyogenic or otherwise, because the treatment aimed at their exclusion and destruction has resulted practically in the clinical banishment of serious wound infection.

Ordinarily the wound is dusted lightly with iodoform, boric acid, pulverized, or aristol, etc., then covered with gauze, absorbent cotton and bandages. If the wound was an infected one from the first, or became such through the fault of the operator or dresser, is beginning to suppurate and is surrounded by a zone of inflammation, moist compresses direct from hot mercurial (or other antiseptic) solution should be applied and the wound covered with oil-silk. This dressing may be changed from two to six times in twenty-four hours, according to the severity of

the local symptoms. The further treatment of inflammation and suppuration may be found under their respective headings.

**Preparation of Sutures and Ligatures.**—Some surgeons are quite well satisfied with the goods prepared by reliable firms, and clinical results would seem to indicate that such firms are conscientious and painstaking. Many surgeons, however, prefer to have their supplies prepared by assistants or someone who has had special instruction in surgical cleanliness and is directly interested in the operator's results.

**SHEEPGUT.** This form of suture, coming from the sub-mucosa of the sheep's gut, is regarded with suspicion unless carefully prepared. Anthrax spores find their way into the intestine of the sheep. Hence, when anthrax appears in the skin where the gut suture penetrates it its presence is supposed to be explicable by reason of the origin of the suture material. (Volkmann.) It has been prepared in various ways. It may be boiled in alcohol for an hour and then placed in an alcoholic solution of corrosive-sublimate, one part of the latter to 2,000 of the former. Another method is to immerse the gut for one week in oil of juniper berries, after which it may be kept in absolute alcohol. Immersion for twenty-four to forty-eight hours in ether, followed by preservation in five per cent. aqueous-carbolic solution, is also useful. The tensile strength is nearly always diminished if the gut be soaked in water at the time of operation. Ligatures of this material may be procured in bent glass tubes which are hermetically sealed. The tube is filled with alcohol and contains a dozen ligatures. They are removed by breaking the glass tube. Of course those that are not used must be discarded unless they are again sterilized.

Chromicized gut is used where sutures are required which are not absorbed as readily as the above. Chromic acid is added to a one-twentieth aqueous solution of carbolic acid, till it becomes one part of the former to 5,000 of the latter. The gut is soaked in this for six hours and may then be preserved in ether or alcohol. It is made pliable and more easy of application if immersed in a warm antiseptic solution at the time of operation. It is not damaged by water as the other gut preparations are.

**SILK.** Silk should be boiled in a one per cent. soda solution for a quarter to a half-hour, or wound loosely on glass reels, placed in a test-tube with the end plugged with cotton and steamed for an hour. It may be carried in screw-capped bottles filled with alcohol or mercurial solution.

**SILK-WORM SUTURE.** This is an excellent form of suture and possesses the least tendency to convey infection to a wound of any suture thus far considered. This is equivalent to saying that it is most easily rendered sterile. The writer has often placed it side by side with sheep-gut and silk in the same wound, and frequently observed that it was accompanied with the minimum amount of cutaneous reaction or inflammation. It may be soaked in ether for forty-eight hours, then in a mercurial solution (1-1,000) for an hour. Or, it may be boiled and preserved like ordinary silk. It is doubled upon itself and carried in long screw-capped tubes similar to those in which drainage tubes are preserved, and may thus be kept ready for instant use. It is always rendered more pliable if immersed, for a time before the operation, in warm carbolic or mercurial solution.



**SILVER-WIRE.** As before mentioned, this form of suture is fast being displaced by the silk-worm suture. It is rendered sterile in the same manner. It is not very pliable and is drawn taut by twisting with the forceps or specially arranged twister. By this means much tension can be obtained and hence it was formerly in extensive use for suturing the cervix uteri, but when the indurated cervical tissue is properly removed there is no difficulty in obtaining perfect coaptation by means of silk-worm suture. In fact, both the wire and silk-worm suture have been discarded by many, even in trachelorrhaphy, because of the bother of removal, and sheepgut sutures have been found quite satisfactory. The silk-worm suture is used largely in closing wounds in the abdominal wall.

For all ordinary purposes the above mentioned sutures are quite sufficient, although other varieties such as whale-tendon, horse-hair, etc., are sometimes used.

**GUT WOOL (Halstead).** The dried sub-mucosa of the sheep's intestine is moistened by means of absolute alcohol, after which it is cut into fine shreds. It is kept in an alcoholic solution of bichloride of mercury, 1 to 1000. It is used for suppressing hemorrhage from bone, the wool being pressed into the bone with pointed forceps. Of course it does not require to be removed, being readily absorbed.

**SPONGES.**—No substance has, as yet, been found that is so effective in taking up the blood and keeping the operative field clean as the sponge. This, however, is offset by the difficulty encountered in keeping it sterile. This is attempted in various ways. The following answers perhaps as well as any: The sponges are first cleaned of sand, shells, etc., by thoroughly beating and washing them in warm and cold water, the water being changed till it is no longer soiled by washing. Then they are wrapped in a towel or placed in a muslin bag, and immersed in a one per cent. soda solution which has just been brought to boiling point and then removed from the fire. They remain in this for an hour. If preferred the soda may be washed from them in cooled boiled water. They are kept, ready for use, in a solution of 1 to 2000, bichloride of mercury. Another method is to immerse them for twenty-four hours in a 1 to 500 solution of permanganate of potash, after they have been beaten and washed as above. Then they are allowed to remain until bleached in a one per cent. solution of hyposulphite of soda to which eight per cent. of hydrochloric acid is added. It is a matter of regret that sponges are so difficult of sterilization, but the texture is such that their usefulness is practically destroyed by boiling, hence they are regarded with suspicion by many. The sponge that has been used in connection with a septic case should be thrown away. Many operators have discarded them altogether and use instead sterilized wipers of gauze. Small pads (one to two inches square) are made of several layers of folded gauze with the cut edges turned in. These answer for general work, but much larger ones are required for abdominal work. Others are made by wrapping plain gauze around absorbent cotton and then tying the corners and edges of the gauze with white thread. These are to be boiled or steamed with the instruments. Some surgeons use the gauze for wipers, without folding it or wrapping it about cotton. They claim that the thread from the loose edge does no harm. This method of wiping wounds is attended with much less danger of infection than when sponges are used, because the

wipers are so readily sterilized and are not used the second time. Being much cheaper than sponges they are thrown away when soiled.

**Preparation of Dressings.**—Ordinary bleached cheese-cloth comprises the major portion of the dressings. It is first boiled for two hours in water rendered alkaline by the addition of carbonate of soda, after which it is rinsed in cooled boiled water and will then be found sterile and absorbent. It may be carried in sterilized glass jars, but if any doubt exists as to its sterility it can be boiled or steamed with the instruments and not again touched till applied to the wound directly from the sterilizer. From this plain absorbent gauze the various antiseptic varieties of gauze are made. If sublimate gauze is desired the plain sterile gauze is soaked for twenty-four hours in a solution of bichloride of mercury (one part), table salt (two parts) and water (500 parts). It is preserved, dry or moist, in glass jars. It is well to immerse and wring out in a weaker mercurial solution before applying to the wound. Or, plain sterile gauze may be immersed in a sublimate solution, freshly made at the time of operation and applied to the wound.

Iodoform-gauze is made by rubbing iodoform into the meshes of sterilized gauze which has been moistened in boiled water. It was formerly prepared by dipping it in an ethereal, alcoholic or glycerine solution containing the dissolved iodoform. It is now believed by some that the iodoform is easily decomposed after dissolving in ether, and that glycerine decreases the absorbent power of the gauze. In spite of its odor, in spite of the laboratory attacks, both iodoform and gauze impregnated with it are still held to be of undoubted clinical utility. While free iodoform is not now regarded as so markedly germicidal it is admitted that it retards the growth of pyogenic bacteria, inhibits sporulation, is destructive to the bacillus of tuberculosis, and renders the sympathetic nerve branches more or less insensitive to bacteric irritation. (See Maylard in *Annals of Surgery*.) Iodoform-gauze has a place chiefly in packing deep or foul wounds and for draining or walling off the abdominal viscera. It is rendered portable by packing as advised with the other varieties of gauze. Iodoform powder in collodion (one to ten) is used for hermetically closing small or perfectly aseptic wounds.

As before stated the tendency is toward simplification of wound-dressing, and hence the enumeration and preparation of many forms of dressing are omitted, among them the double cyanide of mercury and zinc, borated and salicylated gauze, etc. The writer believes that while the surgeon is obtaining good results with a certain kind of dressing it is inadvisable to substitute various others—that it is always best to try to acquire a knowledge of the applicability of a dressing and adhere to its use till a change in condition demands a change in dressing.

**PROTECTIVE.** This is used mainly in plastic surgery—especially over skin grafts—to prevent the dressings from adhering to the wound, and to aid in distributing the discharges through the dressings. Lister's protective gutta-percha tissue or oil-silk, answers this purpose. It is soaked in a carbolized or mercurial solution and the moisture shaken off before it is laid upon the wound. If laid upon skin-grafts the antiseptic solution should be rinsed off in salt solution.

**COTTON-BANDAGES AND PINS.** Cotton, either plain or mercurialized, is used in abundance over the gauze dressing. The first bandage

applied may properly be of gauze and wrung out of a mercurial solution. Over this the ordinary muslin roller is applied. Good sized safety-pins or the ordinary black pins should be used and may be kept in alcohol.

**Medicated Solutions.**—BICHLORIDE OF MERCURY is used in a solution of 1-500 or 1-000 for purposes of external cleansing; for irrigating wounds, vagina, etc., from 1-2000 to 1-5000 is the usual strength. In serous cavities it is not generally used, but if at all in much weaker solution, 1-10,000, e. g.: The ordinary bichloride tablet added to one pint of water makes a 1-1000 solution. The commercial tablet prepared with the addition of tartaric acid is said to prevent the neutralization of the mercuric solution by its contact with the albumin of the blood and serum.

CARBOLIC ACID is sometimes used for sterilizing instruments, the strength of the solution being 1-20. The instruments are immersed in this for a quarter to a half hour. This solution is very irritating to the hands, injurious to instruments, and far inferior to the soda solution already mentioned. Dressings are sometimes impregnated with 1-20 solution. It is quite volatile. This was Lister's first antiseptic and although he (and the majority of surgeons) had almost discarded it for years he has again resumed its use. It is claimed that there is less danger of its being absorbed if applied in full strength than if diluted. It is used in full strength in foul, sloughing or infected sores, and seems to destroy the tissue to a degree that prevents further absorption.

CREOLIN is used, though not extensively, in 5-10 per cent. solution for much the same purposes as carbolic acid.

PEROXIDE OF HYDROGEN may be used in full strength (some brands being quite unirritating) or diluted to any required strength. It is useful in washing out suppurating or fistulous tracks and pus cavities, and for sterilizing mucous surfaces. It is probable that it is not so highly destructive to pyogenic processes as has recently been claimed, yet it seems to possess considerable clinical efficacy. Text-books have stated that its effervescence was unfailing evidence of its contact with pus. This is an error, as it effervesces in contact with blood, serum, etc.

BORIC ACID is employed in almost any strength, from a saturated solution down. This solution is used freely in the bladder or other mucous-lined absorbing cavities and is unirritating and non-toxic.

THIERSCH'S SOLUTION. (For Formula see p. 125.) Tablets are now manufactured with which this solution can be readily prepared. It is an excellent application—used in the form of wet compresses—to foul or irritable sores, and, like the preceding solution, may be used freely in bladder, abdomen, etc.

CHLORIDE OF ZINC is occasionally applied (in the proportion of forty grains to an ounce of water) to infected wounds or sores. This is quite powerful.

CALENDULA has been styled an antiseptic. Aqueous solutions, varying in strength, are applied directly to the wound surfaces. The writer has employed bacteriological aid to determine the anti-pyogenic properties of this drug. Five c.c. of the tincture was placed in contact with ten c.c. of bouillon cultures of staphylococcus pyogenes and streptococcus pyogenes, without retarding their growth in the least. Not only that, but a large, mobile bacillus from which sub-cultures were made was found present



and active in the drug fluid, possibly having been in the bottle before it was filled. These experiments were repeated with equal proportions of the drug tincture and the bouillon cultures with the same result. Neither the streptococcus nor the staphylococcus were influenced till the proportion of the drug fluid so exceeded the culture bouillon that the latter was slightly precipitated. The growth was then only retarded. This was probably the action of the alcohol. It is quite probable, therefore, that whatever clinical value it possesses is not due to the bactericidal properties that have been claimed for it.

**Asepsis.**—When the operative field, the hands of the surgeon and assistants, the instruments, sutures, ligatures and dressings are free from influences capable of producing wound infection the condition known as asepsis has been reached. This is the surgical ideal and is obtained by the employment of efficient means for destroying or excluding septic material. Such means are mechanical, chemical and thermal, either separately or combined. The student will therefore perceive that asepsis is the condition which obtains after the efficient application of antiseptics, and that, strictly speaking, it is impossible to separate the two. This has been attempted, however. Some surgeons follow the rules of antiseptics to the letter except in the matter of applying dressings and solutions of a germicidal nature to the wound. The operative field is scrubbed and sterilized, the instruments, sutures, ligatures and sponges are prepared as under the former method. Dressings and solutions contain no chemical germicides. Such is said to be aseptic surgery, in contra-distinction to the antiseptic method. Obviously such a classification is incorrect, for thermal sterilization is just as much antiseptic against poison as is chemical sterilization. Consequently the so termed aseptic surgeon becomes such in so far as he resorts to antiseptics. The trend of the times, however, is toward achemical surgery, especially in abdominal work. The serous surfaces, and particularly the peritoneum, are normally bathed with fluid possessing anti-bacterial properties, and hence there seems to be less necessity for the application of artificial germicides. It is probably for this reason that achemical surgery has achieved its greatest success in the domain of specialism rather than in general surgery.

Heat is the most efficient antiseptic now in use, and the firmest advocates of chemicals would gladly lay them aside were not wound infection threatened from so many directions. Lister himself has said: "We may possibly dispense with antiseptic applications and irrigation to wounds, provided always that we can trust ourselves and our assistants to avoid the introduction into the wound of septic defilement other than atmospheric."

It cannot be denied that the detail of antiseptic surgery is more or less cumbersome, wearisome and expensive. It is perpetuated, however, by an exacting surgical conscience and the recognition of the fact that the highest degree of success attends the most vigorous attention to detail, which is but evidence that modern surgery has progressed and is based upon higher principles than dramatic brilliancy. And these principles the student must observe. Under no circumstances should he claim asepsis for conditions that are obtained by the mere application of water and possibly soap. These may satisfy the demands of society but not of surgery.

## SECTION VI.

# SURGICAL DISEASES.

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## CHAPTER I.

# SURGICAL REACTION.

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**General Considerations.**—Various types of fever are seen in association with the work of the surgeon, and probably the majority, if not all of them, may be regarded as instances of reaction, the theory having been advanced that such reactionary fevers constitute nature's bonfire, built for the purpose of resisting or destroying noxious matters arising from within or introduced from without. Prior to the practice of asepsis all wounds were supposed to require inflammatory action to secure healing. Since the introduction of asepsis and antisepsis surgical fevers are far less numerous seen. Traumatic fever is seen in association with accidental woundings and operations that are apparently aseptic, though in less severity than in those in which infection occurs during the operation or subsequent thereto. Surgical scarlet fever is occasionally observed, and urethral fever is a common sequel to operations upon the urethra, even resulting from the simple passage of sounds. Septicemia and pyemia also come under the classification of surgical fevers.

Hyperpyrexia may be due to any one of a number of agencies. It is often the result of reflex stimulation of the heat centers. In especially sensitive subjects the passing of the catheter, the introduction of the hypodermic needle under the skin, or the performance of some simple surgical operation is often quite sufficient to excite aseptic traumatic fever. The fracture of a bone, a severe wrench or sprain, or other slight injury may cause pronounced pyrexia, lasting over a number of hours, a day or two, or a few days even. Effused serum or a few drops of pus lying beneath or within a wound sutured with considerable tension has long been recognized as a cause of fever. The febrile manifestations in such cases are not always due to pus infection. The simple release of the retained secretion and the relief of the tension by untying or clipping a tight suture will cause almost immediate subsidence of the fever. That pyogenic organisms are not responsible for the elevation of temperature in every instance is further demonstrated by the fact that a retained blood-clot or even retained liquid blood in a torn part may cause considerable elevation of the temperature. In fracture it is supposed that the liberation of a pyrogenous substance from the injured tissue accounts for the traumatic fever.

Simple traumatic fever is occasionally observed independently of any wounds, being excited by mental emotion, as fear at the thought of undergoing operation. It may arise, also, from simple surgical examination that involves no solution of continuity.

**Aseptic Fever.**—It might be supposed that operations conducted under strict asepsis would be unattended by any manifestations of fever, since none are supposed to occur when operations are unattended by inflammation and suppuration; and practically and comparatively this supposition is correct, traumatic fever not being common to aseptically performed operations. Yet it is not necessarily evidence of sepsis if a rise of temperature to 101 or 102 degrees F. is observed, lasting several hours, or even several days. During infliction and possibly during the healing of wounds minute portions of the tissue are necessarily broken down. Effusion of serum occurs and the fibrinous element of the blood is disturbed. Though not materially altered from their normal condition the effused serum and minute portions of tissue and blood-clot that are absorbed in the healing process result in a pyrogenic action and elevated temperature.

Injury to nerves, whether by incision during the operation or by traumatism, results in disturbance of the nervous equilibrium and, possibly, hyperpyrexia; and even where there is no injury to nerve-tissue the pain and shock incident to the injury from a fracture may act deleteriously upon the heat center and excite considerable rise in temperature without sepsis as a cause.

**SYMPTOMS AND COURSE.** Aseptic fever runs a brief course, is never dangerous, nor are the constitutional disturbances that attend it profound. There may be slight headache, some restlessness and apprehension, thirst, and pain at the site of the injury; but these symptoms subside in the course of a day or two, or a few days at most. If sharp elevation of the temperature occur, with profound headache, thirst, restlessness, and general physical discomfort, the exhibition of aconite, ferrum phosphoricum or belladonna may be permissible.

**MEDICATION.** *Aconite.* This remedy is especially required for sharp rise in temperature, thirst, restlessness, dry skin, dicrotic pulse and hyperesthesia.

*Ferrum phosphoricum.* Ferrum will suit those which may be termed subdued aconite cases. There is little restlessness or thirst, though the temperature may show an elevation of three or four degrees and the patient's face be flushed, with hot head and a moderate degree of headache accompanying. The site of the wound may be red, somewhat tense and moderately painful.

*Belladonna.* This is adapted to cases attended by local redness at the site of the wound, intense headache, throbbing carotids, flushed face, injected eyes, dryness and constriction of the throat, and a tendency toward the mild, wandering delirium that is occasionally seen in aseptic fever.

**Surgical Fever.**—True traumatic or surgical fever is differentiated from aseptic fever by the fact that it is due to ptomaines that are generated at the site of the injury. Bacteria may or may not be found in the blood, and although they may be quickly eliminated their soluble products (toxines or ptomaines) are capable of prolonging the systemic



disturbance. The constitutional symptoms correspond to the degree of injury and the degree of inflammation that are present. Slight delirium is apt to attend this type and the urine is scanty and high colored.

While bacteria, especially the pyogenic cocci, are seen in the few drops of pus that form in the wound yet they are not observed in sufficient quantity to account for the febrile disturbance, hence the pyrexia is thought to be due to the pyrogenic action of chemical substances that are evolved in the wound, for when these are washed away fermentation immediately subsides.

**SYMPTOMS AND COURSE.** The course of simple traumatic fever is not very different from that of simple aseptic fever. The patient suffers from heat, thirst and restlessness. In sensitive subjects there is mild delirium. By the afternoon of the second day the temperature will have reached an elevation of 102 or 103 degrees. It drops in the morning and rises in the evening, attaining a higher register each succeeding evening, until the retained secretions have been allowed to escape and the wound has been cleansed. While the duration of the traumatic type of surgical fever is not usually more than a week, in severe cases it may last longer and the constitutional symptoms may be more profound than already described. If the wound tension be allowed to continue and there be retention of poisonous ptomaines fermentation occurs, with a certain degree of aseptic inflammation. This is especially likely to occur if the wound be infected at the site of one of the sutures while traumatic fever is present.

**TREATMENT.** The treatment of surgical fever consists in the removal of the cause. As soon as it is observed that the condition of the wound is not healthy it should receive antiseptic treatment. All tight sutures should be snipped, and, if necessary, the wound should be opened at its most dependent portion and cleansed with peroxide of hydrogen, dilute carbolic acid, or a bichloride wash, the wound or injury being subsequently dressed antiseptically.

**Medication.** In simple aseptic fever, aconite, ferrum phosphoricum or belladonna may be required over a few days. In the treatment of surgical fever if the wound threatens an unhealthy state arsenicum, lachesis, hepar and silicia will be found useful. Special indications are not required.

**Suppurative Fever.**—Suppurative fever or hectic fever, also termed secondary wound fever, arises from the formation of pus in a wound and the retention and absorption of chemical poison due to the presence of the pyogenic cocci. The nature of the poisonous substance causing suppurative fever is not fully understood. The pus-coccus is occasionally found in the blood, but its presence is not at all regular, and it will be remembered that pus-bacteria are sometimes seen in the blood without febrile disturbance. It is doubtless the presence of pyrogenic materials from the destruction of tissue that produces this fever. It is enough to suggest that there is a sufficient absence of the progressive infection of the system witnessed in septicemia and pyemia to indicate the possibility that suppurative fever depends less upon pyrogenic organisms than has been supposed. Consequently, secondary wound fever, as the term implies, follows upon traumatic fever, usually showing in the second week of the case.

**SYMPTOMS AND COURSE.** Instead of convalescence promptly following primary surgical fever there is a sharp rise of temperature followed by a chill, or repeated chilly sensations, at the beginning of the second week. The degree of inflammation that has been present in the wound during the course of primary surgical fever is increased, its lips are red and may be sunken, and if it be opened or if a confined drainage-tube be removed there will be an escape of pus. When suppuration is pronounced there will probably be a sharp chill, the temperature rising to 104 or 105 degrees in a few hours. Examination of the wound shows it to be soft and fluctuating from the presence of retained pus. If deep the surgeon will have to depend upon the constitutional symptoms to determine the presence of pus, his suspicions being confirmed by examination of the drainage-tube or dressing. Or perhaps it may be necessary to open and inspect the wound, even wash it out, in order to determine positively the presence of suppuration. If there is considerable secretion in the wound and suppuration becomes especially pronounced the case takes a more chronic course, and the characteristic type of acute suppurative fever is shown in the sharp afternoon rise in temperature, varying from two to five or six degrees, the morning temperature being down to normal or nearly so, in some cases to sub-normal. During the height of the fever there may be headache, nausea, coated tongue, general heat of the skin, rapid pulse—occasionally full and bounding, at other times weak and thready—and the characteristic hectic flush or circumscribed redness of the cheeks that gives this type of fever its name. In severe cases profound constitutional disturbances are witnessed. Extreme prostration and rapid emaciation, with colliquative diarrhea and a degree of relaxation of the system resulting in sweatings whenever the patient falls asleep, are observed. Bed sores appear upon the parts lain upon, and as the emaciation progresses the joints become enlarged and tender, the features sunken and hippocratic, and, because of the retrograde metamorphosis of the albuminoid constituents of the protoplasm of the cells, amyloid degeneration of the tissues and organs occurs. The spleen, liver, kidneys, heart, intestines, smaller arteries and even the lymphatic glands are so affected. (Billroth.)

The course of suppurative fever may drag along over a period of weeks, presenting many of the surface indications of septicemia. It is, however, a distinct disease and should not be mistaken for the latter. The importance of recognizing the degenerative changes that take place during the course of secondary surgical fever is apparent. No severe surgical operation will be expected to be attended by success if the nobler organs of the body are involved in an attending amyloid process.

**TREATMENT.** The correct surgical treatment of suppurative fever belongs to the first stage. All unhealthy wounds should be immediately opened and thoroughly cleaned. If there is shown to be retention of pus at the site of an injury or operation, with our present understanding of the etiology and pathology of surgical fever immediate opening and antiseptic cleansing of all suppurative wounds are imperatively demanded. Incisions and counter-openings should be sufficiently numerous and free to thoroughly open the affected site. The wound should be cleansed with peroxide of hydrogen, and when permissible with mercuric bichloride, packed with bichloride or iodoform-gauze and dressed frequently. If the

suppurative process has become well established the wound should be thoroughly curetted, all unhealthy granulations and infected tissues being removed. If it be a joint that is affected this should be curetted and cleansed as well as possible; but resection is not permissible if amyloid degeneration is going on, this being determined only by careful urinary analysis. In addition to surgical care the patient demands stimulation and a thoroughly nutritious diet.

*Medication.* The remedies that will be required in the treatment of suppurative fever are hepar, silicia, arsenicum, carbolic acid, china, carbo vegetabilis, lachesis and chininum arsenicosum.

Arsenicum is perhaps, the most useful of all. It meets the repeated shiverings, with exacerbations of fever, weak, thready pulse, debility, colliquative diarrhea and general relaxation of the system.

China is always to be thought of in connection with severe drains upon the vital fluids; it is an excellent remedy in suppurative fever when the suppuration is profuse and especially if the pus be thin and sanious. There are headache, languor, and periodic aggravations of all the symptoms.

Though not so likely to be called for in suppurative fever, yet where a profound degree of systemic debility is seen with very weak heart action and palpitation, the appearance of the sore being unhealthy and the pus flocculent, lachesis is a remedy of first importance. The tendency of the patient is to a low typhoid state, with muttering delirium.

Hepar sulphur will be required in the characteristic hectic flush of suppurative fever, with sweats, relaxation of the system and copious outpour of pus.

Silicia will be found useful in unhealthy wounds and in checking protracted suppuration. It is more useful, as is hepar also, after the acute febrile symptoms have subsided. China and arsenicum are more useful while the fever is on.

Other remedies that may be demanded occasionally in unusually severe cases, with debility of the vital forces, are carbo vegetabilis, phosphorus kali phosphoricum, mercurius and veratrum.



## CHAPTER II.

### ERYSIPELAS.

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**Definition.**—Erysipelas is a contagious disease characterized by inflammation of the skin and subcutaneous tissue, formerly held to be an idiopathic disease but now understood to be due to an infective cause and not infrequently seen among the infective surgical disorders.

**Etiology.**—Erysipelas is due to the microphyte of Fehleisen. It is identical with the streptococcus pyogenes of abscesses, and is also seen in the lochial discharge and in the peritoneal fluid in more severe forms of puerperal fever. It takes the form of a sinuous chain, the individual globules of which have a tendency to collect and hang in couples. It is capable of cultivation, and if inoculated in the human subject produces the characteristic erysipelatous fever and exanthemas, as in its natural habitat. It is of the order of the saprophyte, adhering to particles of dust and thus being capable of transmission from one subject to another. It is easily destroyed by germicides. When cultivated it attains its growth within about four days and loses its virulence within a few weeks, dying out and becoming altogether innocuous in about four months.

The micro-organism of erysipelas gains access through wounds of the skin. It is possible that the site of infection may be altogether overlooked and that the injury through which the infection occurs may consist of but a minute abrasion. It seems to follow idiopathically upon cold, raw winds, and an erysipelatous dermatitis is often produced by bathing the face, while hot, in ice-cold water. Certain constitutional states predispose to the development of erysipelas, as Bright's disease, the drink habit, faulty or insufficient nourishment and, in general, unsanitary surroundings and unhygienic modes of living. Surgically it follows injury of soft tissues and is also seen as the result of or in association with carbuncles, boils, and other inflammatory states. Fehleisen and other continental writers hold that the erysipelatous coccus is morphologically distinct from the ordinary pus-producing cocci; and the fact that inoculation by it results in the development of erysipelas instead of a typical septic state would seem to support this view. Erysipelas sometimes follows vaccination when improperly performed and when impure virus is used. Not all poisoned vaccination sores are erysipelatous, however; some partake of the character of septic sores without erysipelas. It seems to have a definite relationship to puerperal fever, and the lying-in state may be considered a predisposing cause. It is seen to prevail epidemically in maternity wards, in army hospitals, camps and prisons. In former days it prevailed in epidemic form over large areas of country. Epidemic erysipelas attacks the mucous membranes, causing intense phlegmonous inflammation in the throat and mouth with extensive inflammation of the muscles of the trunk and neck. It has not been seen as a general epidemic in this country for some years.

If erysipelas begins in the skin an erysipelatous inflammation will be the result, while if it invades the deeper tissues the case becomes one of phlegmon, formerly called phlegmonous erysipelas, but now usually treated of as a separate ailment under the name of phlegmonous inflammation.

**Site.**—The natural location of idiopathic erysipelas is upon the site of a wound, especially in the skin of the face and scalp. It is also quite often seen about the umbilicus (known as omphalitis), on the arms, and in the pharynx and nares. If it is present in the parturient woman it partakes of the character of puerperal septicemia, with the vagina, uterus, and peritoneum as the chief sites of the inflammation. If it occurs as the result of vaccination or a surgical operation it will probably develop at the site of the wound. This is also the case when erysipelas is seen in association with wounds the result of accident.

**Symptoms and Course.**—Erysipelas is usually ushered in by shivering sensations or a positive and well-defined chill. The temperature quickly bounds to 104 or 105 degrees in profound cases by the first evening, attaining its maximum by the end of the third day. In rare and unusually severe cases it may attain the height of 106 or even 108 and be maintained at a moderately high register as long as the inflammation lasts. It presents a characteristic evening exacerbation.

With the subsidence of the chill and development of febrile symptoms a spot of new inflammation develops, at the site of existing inflammation, always so when associated with surgical wounds or severe traumatism. This quickly spreads over a considerable area. The inflamed part is painful, red or reddish-brown in color and the tissues are swollen. As the disease progresses the skin and sub-cutaneous tissue become infiltrated and pit upon pressure. At this stage the skin presents a brawny hardness. In some cases vesicles form which are filled with a serous fluid. If the case is quite pronounced headache, nausea and repeated chilliness during the fever occur. Delirium is more likely to be seen when the face and scalp are the site of the inflammation. The tongue is coated with a thick, creamy fur. The eyes become sallow and icteric, and the skin presents a peculiar dusky-yellow color. The temperature remains rather uniformly high during the first three or four days, presenting its evening exacerbation over a few hours and, as the symptoms subside, showing alternate elevations and depressions two or three times during the twenty-four hours; though in some cases the remission occurs regularly in the morning hours with exacerbations of the temperature and other symptoms in the afternoon and as night comes on. In unusually severe and protracted cases a typhoidal phase is observed with low, muttering delirium, diarrhea, depression of the pulse, and a general sunken state. If the delirium be constant it is thought to be due to occlusion of the cerebral capillaries.

With the subsidence of the active inflammation of erysipelas the affected part becomes softer, darker in color, and a bran-like desquamation follows. If the skin has been very much thickened a slight degree of induration remains for some time.

The streptococcus of erysipelas is found especially in the capillary lymphatics of the skin, and sometimes in the capillary blood-vessels and small veins, when the micro-organism spreads out by long shoots or

extensions of the inflammatory process, attacking fresh areas as its first site heals. This form is called *erysipelas erratica*. By spreading in this manner a considerable proportion of the surface of the body may become invaded; the inflammation may even reoccur in patches of integument that have already been affected before the cure of the case is complete.

Erysipelas occurring in connection with surgical wounds or local injury, no matter what the cause, begins at the margin of the wound. Here it is generally bright red in color, becoming dingy later. As the inflammation spreads the skin is raised so that this margin is clearly defined. If the immediate neighborhood of the affected tissue be plentifully supplied with loose cellular tissue the swelling may be very pronounced. When this is the case there is less pain than where the tissues are tightly drawn over firmer tissues beneath. When severe and occurring upon the face it may so disfigure the subject as to render him almost unrecognizable.

If it occurs near lymphatic glands these are usually swollen and tender. Erysipelas of the hand or foot may also cause extensive swelling and soreness of the glands of the axilla or groin. When the face is involved the submaxillary glands are enlarged, and if the ears or scalp be the site of the disease the cervical glands are affected. In rare cases in subjects of constitutional dyscrasie suppuration of the lymphatic glands may result. Occasionally swelling of the glands is the first local symptom of infection.

**Pathology.**—Erysipelatous inflammation results in a diffuse spreading of inflammatory exudation, the inflamed tissues being occupied by a serous liquid and fibrinous precipitate. Leucocytes are seen in abundance along the blood-vessels. The specific coccus of the disease is found at the margin of the blush of redness but not in the later stages of the inflammation. It seems not to infiltrate the blood-vessels, being confined to the lymphatic spaces and lymph radicals. It is especially abundant in the lymph spaces, so much so that complete obliteration of these is seen in pronounced cases. The rete Malpighii of the epidermis is so infiltrated with effused liquid that it becomes vacuolated and opened out into a trellis-work sort of structure. (Hamilton.)

When this infiltration is excessive vesicles or bullæ form on the surface. If the disease occurs in hairy parts the small cell infiltration invades the root-sheaths of the hair and it is shed as the disease progresses.

The most frequent point of entrance of the cocci of erysipelas is through a wound and, spreading from this point, through the lymph capillaries of the surrounding skin. The disease is not always manifested, though usually so, at the point of entrance, occasionally developing as an inflammation at a point quite remote from some slight laceration or puncture of the skin or mucous membrane through which its poison gains entrance.

In severe cases the blood is liquefied and uncoagulated. The spleen is softened and the kidneys are engorged; the lungs are congested from the smaller vessels being blocked with granular masses, and a similar condition is described as having been observed in the blood vessels of the brain. In rare cases the kidneys show interstitial inflammation, and casts and albumin are seen in the urine.



**Phlegmonous Erysipelas.**—Phlegmonous erysipelas is a severe variety in which the skin becomes tense and hard, vesicles or bullæ forming that are filled with a clear serum and subsequently with a bloody fluid. The surrounding parts present an unusual degree of swelling and edema, the fever being more pronounced than in the simple variety, suppuration following, resulting in more or less separation of tissues and sloughing. Where the inflammatory process in the sub-cutaneous tissue has been severe and the skin resists disintegration it may be elevated from the muscular structure for an area of several inches, the interspaces being occupied by broken-down connective tissues. In individual instances there will be considerable collection of pus, which upon incision is allowed to escape and is seen to be bloody, thin and containing more or less shreds of sloughing tissue. Masses of necrotic tissue are sometimes thrown off through an opening caused by sloughing of the skin or through surgical incisions. In this type the pus may burrow between the muscles, affecting the periosteum and eventually the bone, or it may be the cause of erysipelatous synovitis. If a considerable area of skin be separated by the burrowing of pus and extreme distension occur at the margin of the phlegmon the skin may be so deprived of its nourishment as to break down and become gangrenous. When this is the case considerable-sized bullæ that are filled with bloody serum of an offensive odor and exceedingly ichorous are seen to form above the gangrenous mass. This destruction is sometimes limited to a small area; in other cases it is extensive, causing death of considerable-sized areas of integument and severely involving the deeper tissues.

Phlegmonous erysipelas is attended by severe constitutional symptoms, as continuous elevation of the temperature, thirst, nausea, diarrhea, delirium, meteorism and, in unfavorable cases, a general septic state of the system. Phlegmon is seen in erysipelas of the calf or thigh, about the scrotum, in rare cases about the face and neck and, in fact, wherever the skin is underlaid by loose connective tissue.

**Diagnosis.**—The diagnosis of erysipelas is easy. In none of the local inflammations to which the human species is liable is there a more sudden rise of temperature. The lymphatic glands of the immediate vicinity are enlarged and tender, and in pronounced cases red streakings extend from the inflammatory spot along the course of the lymphatics for some distance. The sharply defined swelling, roughness, and redness of skin are decided and pathognomonic.

When occurring in the throat erysipelas presents the characteristics of a general pharyngitis, but it is a profound inflammation with extensive edema, severe pain and mucous membranes of dark color. The constitutional symptoms are severe, as repeated shiverings or positive chills, headache, intense heat and burning in the throat, aphonia, painful deglutition, swelling of the submaxillary glands and profound physical prostration. The evening exacerbations of fever are quite characteristic, and the unusually high degree to which it quickly attains suggests erysipelatous pharyngitis. The mercury may register 107 or 108 degrees at the end of the second or third day in malignant cases, and the edema and inflammation of the mouth and throat may be extreme.

**Prognosis.**—The prognosis of erysipelas will depend in great measure upon the age of the patient, the general state of his health and his

surgical condition. Very old subjects often die from erysipelas. In youths and persons in middle age recovery is the rule. Violent types of erysipelatos inflammation about the head are more dangerous than when they occur in other parts of the body, unless associated with an open wound. The darker the eruption the severer the case, and when jaundice, delirium, very rapid pulse, effusion of blood into the vesicles, diarrhea and perspiration accompany erysipelas the prognosis is grave. The chief danger in erysipelas of the mouth and throat lies, first, in edema of the glottis and neck, and, second, in the liability to broncho-pneumonia. In subjects of Bright's disease or other constitutional disorders the prognosis is more grave; for here the danger is in proportion to the degree of prostration that is developed, and also in proportion to the effect of the new disease upon that already existing. Acute Bright's disease may be lighted up in a subject of chronic Bright's disease by an attack of erysipelas and terminate fatally.

The occurrence of erysipelas in connection with surgical wounds may be followed by extensive phlegmonous inflammation and a general septicemia may be developed. In severe cases erysipelas may result in gangrene.

**Treatment.**—The treatment of erysipelas is constitutional and local, especially the former. In the practice of the old-school constitutional measures have been depletive or supportive, depending upon the character of the case. Depletion was formerly the rule and consisted of venesection, purgatives and emetics. Later it has been supportive, consisting largely of the administration of iron. For purposes of purgation it has been the practice to use the effervescent salines. In old subjects a supportive treatment has been used, as the administration of beef-tea, meat-jelly, a mixture of sherry and champagne, digitalis, and quinine. Camphor has received some favor and the commercial antipyretics have recently been in favor.

**LOCAL TREATMENT.** Numerous external applications have been recommended in the treatment of erysipelas, chief among which have been iodine, carbolic acid, kreosotum, alcohol, veratrum viride, glycerine, oxide of zinc and starch, acetate of lead, nitrate of silver and perchloride of iron. Sometimes surrounding the affected area with collodion tends to circumscribe the inflammation. Carbolic acid seems to have received more favor, it being administered by sub-cutaneous injections of a two or three per cent. solution every day or two at first, the injection being administered at the margin of the disease-area, the solution being spread out over as great a surface as possible under the skin. Later four or five doses daily are injected. At the same time a two per cent. solution of carbolic acid in vaseline is applied over the inflamed surfaces. In mild cases the external application alone is practiced. Concentrated solutions of salicylic acid or the sulpho-carbolate of soda have been administered by hypodermic injection, and used locally also. Recently the application of alcohol by pledgets of cotton saturated with it and bound over the surfaces that are affected is being preferred by some surgeons. Iodine, applied over the affected area and on the healthy skin surrounding it, has long been a favorite application. Weak solutions of nitrate of silver applied in the same manner have been extensively used also. Compresses

coming from a mercurial or bicarbonate of soda solution are also recommended.

In homeopathic practice the best external applications are weak solutions of the tincture, or alcoholic dilutions, of the remedy given internally. *Cantharis*, *urtica urens*, *apis*, *belladonna* and *rhus tox*, in the medium dilutions, and perhaps other remedies, have been used with benefit. In ordinary cases constitutional treatment alone suffices to promptly cure. In severe cases a combination of constitutional and local treatment will be required. An ethereal solution of iodoform has been recommended in severe vesication and suppuration. (See Treatment of Suppuration and Abscesses.)

**MEDICATION.** *Aconite*. In the initial stage of erysipelas, attended by chill, repeated shivering sensations, with quick, wiry pulse and a rapid rise of temperature, aconite will be found an exceedingly useful remedy. It should be given in the lower attenuations, frequently repeated for the first twenty-four hours, when this group of symptoms is present.

*Ferrum phosphoricum*. This remedy is better adapted to the mild types, especially facial erysipelas, with mild fever, less pronounced chill, flushed face, throbbing but not severe headache, the features of the case partaking more of the type of inflammatory erysipelas than constitutional infection or the phlegmonous variety.

*Belladonna*. It is especially indicated in erysipelas of the face and head. The eruption is bright red, or purplish, the eyes are injected, the headache is severe, delirium comes on early, the rash is smooth and deep red, and the affected area is intensely swollen.

*Rhus tox*. *Rhus* is suited to the dark red and vesicular variety with general vesication, the vesicles being filled with clear serum. The case assumes a low, typhoid character with less active delirium than belladonna, and has pronounced nightly aggravations. Erysipelas resulting from exposure to wet and preceded by muscular pains and achings in the joints and bones is responsive to *rhus tox*.

*Apis*. This remedy is very like belladonna. The pain is more acute, however, of a burning-stinging character, and the edema is extensive. *Apis* is especially applicable when the inflammation attacks the loose cellular tissue and distension and brawniness of the skin are pronounced. *Apis*, *belladonna* and *rhus tox* are especially applicable in erysipelas of the mouth and throat. With belladonna the mucous membranes are bright red or phlegmonous. With *apis* they are extensively swollen and edematous. With *rhus tox*, the tongue takes on the typhoid dryness and the throat is especially painful upon efforts at deglutition. The sensation when belladonna is called for is that of intense burning; with *rhus* the pain is of an aching character, with a sense of lameness and soreness upon efforts at swallowing.

*Cantharis*. *Cantharis* is indicated in a high grade of erysipelatous inflammation with quick formation of small vesicles. *Cantharis* and *apis* are particularly useful in erysipelas about the genitalia.

*Arsenicum*. This remedy suits in low grades of erysipelas with general prostration and diarrhea, putridity of the inflamed area, weakness of the heart, nausea and a low sunken state of the system. It is also especially indicated when the diseased part has a tendency to become gangrenous.



*Lachesis* and *Crotalus*. These remedies may be needed in erysipelas tending to gangrene, and in low debilitating states of the system in connection with erysipelatous inflammation. *Kali phosphoricum* may also be called for in like conditions.

*Kali muriaticum*. *Kali* is homeopathic to vesicular erysipelas with the formation of large bullæ.

*Silicia*. *Silicia* will be needed in protracted suppuration following erysipelas, showing a general unhealthy erysipelatous state of the skin. *Hepar sulphur* may also be needed in similar states.

### CHAPTER III.

## GANGRENE.

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**Definitive Considerations.**—Gangrene, “to gnaw,” applies to the mortification or necrosis of the tissues of the body. Ulceration is another term applied to destruction of human tissue, but it is differentiated from gangrene, an ulcer being less extensive in area and less malignant. Necrosis is another pathological term meaning gangrene, but, surgically, this word is used more generally in association with death of bone; it is equally applicable, however, to the death of any structure. The term gangrene is generally applied to the death of a portion of the surface of the body, while necrosis, when used in connection with destruction of soft tissues, is more frequently applied to internal organs or sub-cutaneous structure.

Gangrene is divided clinically into two varieties, dry and moist.

**Dry Form.**—In the dry form the skin shrivels, is at first pale or of a white color, semi-translucent in appearance, with specks of a bluish-mottled hue on the surface. As the disease progresses the mottling increases and the opacity is lost, until finally the gangrenous surface becomes dark, even black and mummified. Owing to the fact that there is no moisture in the gangrenous tissues there is no putrefaction, the part simply shriveling in a dry form of death. Dry gangrene is the result of arterial disease whereby the arterial supply is cut off and no fluid is brought to the dead part, the veins and lymph-channels remaining unobstructed, leaving no venous blood in the affected area, dryness resulting from gradual evaporation of the moisture inherent in the diseased tissue. The discoloration that is seen, first as mottled speckings and subsequently as large areas of black, results from retention of the coloring matter of the blood. Eventually the tissues of dry gangrene become hardened almost to a leathery consistency.

Dry gangrene is especially a disease of advanced years and is seen in people of thin, scrawny and emaciated habit; or it may occur in better-nourished subjects suffering atheromatous, syphilitic, or tuberculous disease of the blood-vessels. When occurring in portions of the leg that are better nourished there will be a moderate degree of putrefaction in connection with the senile variety. The degree of moisture and tumefaction will depend upon the degree of occlusion or contraction of the lymph-channels. When the calf of the leg is involved there is sufficient moisture by the liquefaction of tissue under the influence of bacteria to promote a degree of decomposition that makes the case partake of the character of both dry and moist gangrene, the former being, strictly speaking, the primary ailment.

**Moist Form.**—Moist gangrene has always associated with it a greater or less degree of decomposition. It results from sudden arrest of the arterial circulation, or from death of a part from obstruction of the venous circulation. The part is engorged with blood and the hemo-

globin percolates through and stains the skin, giving to moist gangrene its characteristic dark, even livid color. Bacterial infection entails decomposition of the tissues; bullæ filled with reddish fluid form on the surface, and as mortification progresses gases are developed, with resulting emphysema of the tissue. The tissues are quickly dissolved and melted away by the gangrenous process and the breaking down of blood-corpuscles. The muscular fibres disappear and the nerve-fibres, fat-cells and epidermis, becoming disintegrated, are exuded in an offensive excretion of liquid or semi-liquid character.

The discoloration of moist gangrene partakes of almost all the shades of the rainbow at some stage of the disease. Its characteristic color is a combination of ashy-gray and the various shades of green, to the darkest green and black.

In gangrenous states, especially in moist gangrene, there is an effort on the part of nature to form a line of demarcation between the diseased tissues and the healthy structure. This consists of a red line of demarcation, formed only as the gangrenous process has been held in check. It is bright red in color, standing out in striking contrast to the dark, necrotic tissues of the gangrenous area.

**Etiology.**—There are certain constitutional conditions that predispose to gangrene. Senile gangrene, as the term implies, occurs in people of advanced years, and is almost invariably due to atheroma of the arteries. There are conditions of the heart, as valvular disease and mycotic degeneration, that are also occasionally responsible for gangrene. Protracted illness, as unusually long-continued typhoid fever, severe types of smallpox, puerperal fever, Bright's disease and diabetes are also responsible for the disease; and it is not an uncommon attendant upon intemperance and systemic starvation. Long continued local nerve-irritation, resultant in local inflammation, is also productive of local gangrenous states, and in rare cases sloughing sores of gangrenous type occur from spasmodic vaso-motor constriction, which develops from reflex irritation or which may be due to trophic conditions of the nerves. Acute bed-sores which are not the result of pressure are examples of gangrene from nerve-irritation.

When not dependent upon senility gangrene is most often caused by injury, as crushing of an extremity or sudden interference with the blood supply by injury of an artery or vein, especially the former. Ligation of the femoral artery, or the popliteal, or injury to either, may result in gangrene of the foot. Crushing of any part of the body may cause gangrene. If the circulation be already enfeebled by disease, even slight injuries, as an ordinary bruise of the finger or toe, may result in gangrene of the member. Gangrene from these causes may be seen in parts far removed from the circulatory center, as the fingers or ends of the toes or foot. Gangrene from direct injury may occur in any portion of the tissues.







FIG. 1.  
CAULIFLOWER CARCINOMA OF KNEE.—Emmet L. Smith.

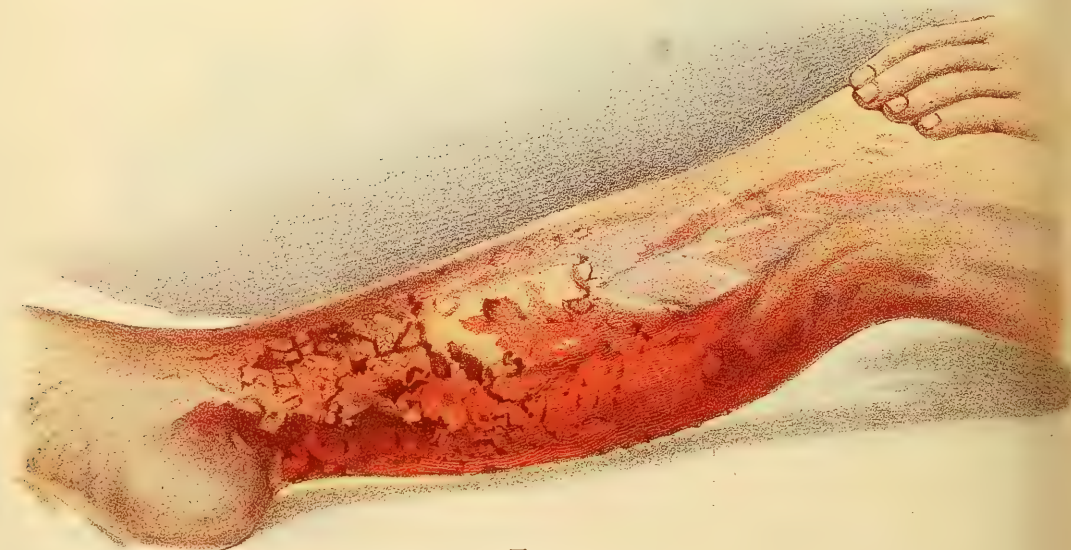


FIG. 2.  
DIFFUSE GANGRENE OF LEG —Emmet L. Smith.

## CHAPTER IV. DRY GANGRENE.

**Senile Gangrene.**—The foot is most frequently attacked by senile gangrene. It is hardly ever seen in the upper extremities, but is first noticed in one or more of the toes or in the foot. The symptoms are redness and swelling with pain and exquisite sensitiveness to touch. If occurring about the joints of the great toe, as is most frequently the case, it may be mistaken for gouty arthritis. At first it is red and inflamed and the characteristic mottling of the surface is observed, rendering the diagnosis certain.

The degree of arterial obstruction is generally sufficient to involve the whole toe, but the process is not apt to extend primarily beyond an individual member. The toe shrinks and becomes dark, even black in color. As discoloration appears the pain subsides, the integument feels dead to the touch and becomes dry and wrinkled. The line of demarcation when formed is seen at the metatarso-phalangeal articulation. If the systemic state is feeble no distinct line of demarcation is formed and the gangrene spreads. Under more favorable circumstances the individual member affected undergoes complete necrosis and falls off, the stump healing by granulation. In typical senile gangrene this favorable result is not common; the inflammation spreads from the first member attacked, and as it extends up the foot a certain degree of moisture and putrefaction from bacterial infection is observed. Thus, what was at first a pure case of senile gangrene now becomes a combination of this type of the disease and moist gangrene, from infection.

As the disease extends from toe to toe and up the foot the danger is greatly increased, and it not infrequently happens that before there is very great destruction of the metatarsal and tarsal portions of the foot the leg will have become involved, the primary cause of the disease being an atheromatous state of the tibial arteries. If the popliteal and femoral vessels are also affected by thrombi the gangrenous process may extend above the knee. Haidenhain found more or less obliteration of the larger blood-vessels of the leg in more than one-half of the cases examined. In a number of cases old thrombi had already become organized.

Thrombus formed at the bifurcation of the popliteal may fill the tibial arteries throughout their whole length.

**Embolism.**—Embolism is a more common cause of gangrene of the foot and leg than thrombus, and when dependent upon embolism the symptoms are more acute. The first symptoms that are felt are sharp pains in the calf of the leg, with early coldness and unusual paleness of the affected part. When these symptoms are present careful examination will reveal the absence of pulsation in the tibial artery. If an embolus lodge at the bifurcation of the popliteal artery a thrombus may form above it and the femoral artery be occluded for a considerable distance.



Embolism that causes gangrene is usually dependent upon organic heart disease or atheroma of large arteries.

**Frost-Bites.**—Gangrene may result from frost-bites due to the direct action of intense cold, or to a combination of cold and an enfeebled condition of the system. It is generally seen in drinkers, old people, and in exhausted and starved conditions of the system. The cold causes the small arteries to contract and if contraction is maintained too long they subsequently fail to dilate and supply blood to the frost-bitten parts. The dry form of gangrene is established and may result in the loss of the injured member and adjacent tissues. The parts are first paled and later become purple or marbled, as the process extends becoming dark, even black. Gangrene is more certain to follow frost-bites upon the application of warmth to the injured surfaces. Intense passive hyperemia with blood-stasis in the part may lead to its death, or to a chronic inflammatory process.

**Ergotism.**—Gangrene is sometimes produced by ergot. Animals feeding upon rye or other grain upon which ergot is found are subject to gangrene from spasm of the arteries. It is rarely seen in the human species from this drug, yet it is possible that ergot is responsible, in part at least, for the gangrenous states that follow parturition where the drug has been carelessly or extensively used. It is also caused by abortion produced by ergot, with subsequent uterine gangrene, in rare instances. The long continued use of ergot for aneurism and for the purpose of causing reduction in size of fibroid tumors has been seen to produce dry gangrene of a distal member and also to induce gangrenous inflammation at the site of injection. The gangrene of ergot does not differ from other forms of dry gangrene. The structures affected shrivel and dry as in senile gangrene, unless they be plentifully supplied with moisture, when the case may partake of the character of combined dry and moist destruction.

**Raynaud's Gangrene.**—Raynaud described a form of gangrene known as symmetrical gangrene. It is of the dry variety, develops symmetrically in the two halves of the body and is not due to embolism, thrombus or arterial degeneration. It has been seen in both the lower and upper extremities and in rare cases in the four limbs at the same time. It is usually seen in anemic subjects and commonly affects the extremities. The cheeks, ears and nose have suffered, and a rare case is reported by Mills in which the tip of the tongue was the organ affected.

Raynaud's gangrene is a peculiar ailment. No characteristic heart-lesion is found, nor are evidences of any organic disease found. Hematuria has been seen in some cases, but is not an invariable accompaniment. The process seems to be due to a disturbance of the vaso-motor system. The affected tissue becomes cold, greenish-blue, and, later, almost black, with very minute blisters on the surface, these containing a sero-purulent fluid, which break and leave excoriations. Local asphyxia attends symmetrical gangrene, the cyanosis varying in intensity. If pressed upon the color deepens from the pressure and returns slowly. As the disease progresses and the tissues become severely discolored the appearance is that of senile gangrene; the latter, however, is rarely bilateral, is much more extensive, and is due to degeneration of the arteries or to obstruction. In symmetrical gangrene such cause is not found, the process



Fig. 1.



Fig. 1. Noma, Cook County Hospital Case.

PLATE III

GANGRENOUS STOMATITIS AND DIABETIC GANGRENE.

Fig. 2 Diabetic Gangrene. Fisher.

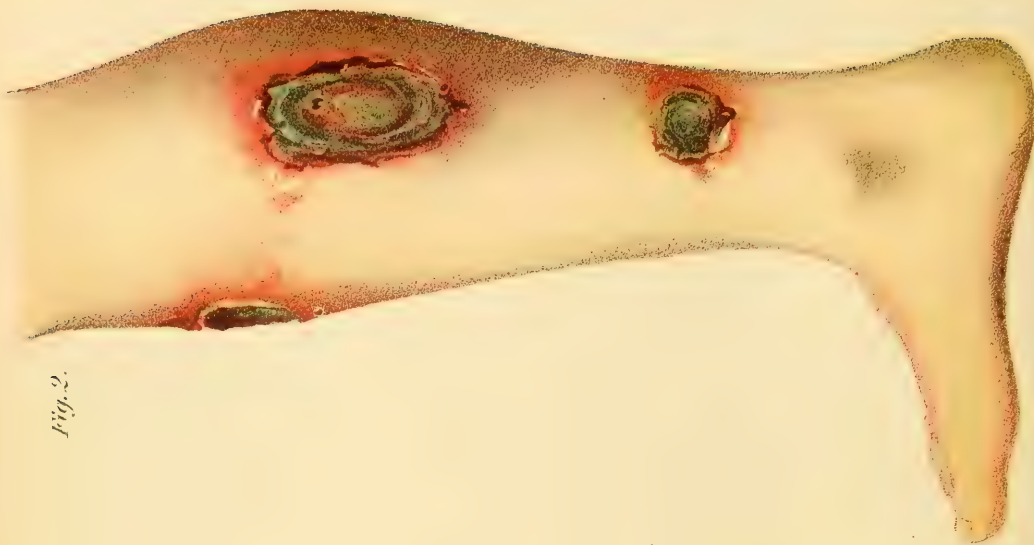


Fig. 2.



is localized and usually lateral. Senile gangrene is progressive and is almost invariably fatal, while the prognosis in symmetrical gangrene is favorable.

The course of Raynaud's disease lasts over a period varying from a few days to two or three weeks, but there may be recurrences extending over a period of several months, or even two or three years. The vasomotor disturbance remains at its height for ten days or two weeks, when convalescence sets in. In some cases this is prompt, in others it is protracted. If the gangrene develops early recovery is usually prompt, following upon the separation of the eschars. In more sluggish cases, especially those seen in anemic subjects, the patient recovers much more slowly, with bone ulcers and recurring localized gangrene distributed over an extended period of time.

Symmetrical gangrene is seen more often in women than in men, the proportion being four to one. It occurs during the earlier years of adult life and its most frequent exciting cause is low temperature. It is sometimes confused in its earlier stages with chilblains; but the latter belong to certain portions of the year, and are not confined to individual parts, nor are they likely to be symmetrically bilateral. Raynaud's disease may be seen at any season, though more common in winter. The gangrenous sloughing and bilateral character are its distinguishing features.

Raynaud attributed this form of gangrene to constriction of the arteries with ischemia, resulting in local syncope, or "dead finger." The veins are contracted and the venous blood flows back into the capillaries, causing stagnation and slight anemia. The symmetrical character of the lesion is doubtless due to irritation of the cord, resulting in spasm of the vaso-constrictors. As stated, four-fifths of the cases of this disease occur in women. It is sometimes seen in the puerperal state, and in rare cases may appear at the menstrual epoch. When the reflex irritation takes its origin in the female genitalia various symmetrical congestions are seen at this time.

**Diabetic Gangrene.**—A form of gangrene occurs in connection with diabetes in elderly subjects that is very much like senile gangrene. The diagnosis will be aided by examination of the urine. Diabetic subjects suffer from furuncles, carbuncles, bed-sores and local abscesses, all of which are liable to become gangrenous. Diabetic patients are bad subjects for the surgeon. They bear surgical operations badly and only when their condition is such as to demand immediate operation, as in spreading gangrene, severe injuries, malignant carbuncles, and other like emergencies, is the surgeon justified in operating.

While accounted among the dry forms of gangrene, this variety is more rapid in its destructiveness than ordinary senile gangrene and partakes more of the features of the combination of dry and moist gangrene. It is seen at the site of any wound, but more commonly affects the lower extremities. Because of the unhealthy state of the general system its course is rapid. Gangrenous spots quickly break down, and furuncles and carbuncles, when seen in diabetic subjects, tend to degenerate into gangrenous ulcers (Plate III, Fig. 2.)

The gangrene of diabetes is due to arterio-sclerosis, as in senile gangrene, the kidneys being responsible for the vascular disease. If amputation is demanded because of gangrene of an extremity the operation should be done far away from the site of the sore. In a list of thirteen

cases of amputation below the knee reported by Haidenhain for diabetic gangrene of a lower extremity two recovered, two died from gangrene of the flaps, and in nine cases subsequent higher amputation was demanded. Of twenty-seven amputations above the knee nineteen recovered, eight dying of diabetic coma.

## CHAPTER V.

### MOIST GANGRENE.

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**Specific Considerations.**—This form of gangrene is occasionally due to weak action of the heart and also to chemical agents that act directly upon the tissues, while a not infrequent cause is injury by burns, especially by scalds, a certain area of local destruction being due to local infection, or, perhaps, to nerve irritation, or to both combined. Certain specific micro-organisms, as those of anthrax, glanders and malignant pustule act with great intensity upon the injured tissues and produce this variety of gangrene. Moist gangrene may also follow erysipelas and the bites of insects and serpents. Escharotic chemical agents coming in contact with human tissues often produce local death and gangrenous sloughing. Not only do the micro-organisms of certain specific diseases favor the development of gangrene in wounds but the ordinary pus-producing micro-organisms, when acting under favorable conditions, may become etiological factors. Gangrenous conditions of the mouth and onychia, furuncles and carbuncles that become gangrenous are doubtless due to infection.

The constitutional disturbances attendant upon moist gangrene are those belonging to acute septicemia. The pulse is small, feeble and exceedingly rapid, the respiration is rapid, the perspiration profuse, nausea and vomiting are often seen and choleraic diarrhea may occur. The temperature varies from 103 degrees to 105 degrees during the acute manifestations, and as death of the structures supervenes and collapse occurs it may rise to 106 degrees or 107 degrees, though it is more likely at this stage to fall to normal or even below normal. It not infrequently happens that the spread of gangrene is so rapid that a few hours will suffice to insure a fatal termination in what might have been a favorable case under prompt action. In a case coming under the observation of the author a compound fracture at the ankle joint necessitated amputation just below the knee within forty-eight hours of the injury. Had the patient consented to immediate amputation he might have been saved several inches of his leg. The importance of promptness in operating in cases manifesting positive evidences of gangrene cannot well be overestimated.

When a limb or other structure is injured and gangrene threatens the part becomes cold and anesthetic and the skin over the affected area is put upon the stretch by extravasation beneath it. The color soon changes from natural, or nearly so, to a dusky hue, and mottling occurs here and there. Later, the discoloration becomes more and more pronounced until it is greenish, greenish-black, and finally almost or quite coal-black. Vesicles appear over the gangrenous area filled with a reddish fluid, which is sometimes exceedingly offensive and ichorous. As the extravasation increases and decomposition occurs emphysematous crepitus is imparted to the touch. The epidermis becomes detached from the corium and separates in sloughs, the fluids beneath and the decomposing



tissues emitting an offensive odor, in pronounced cases amounting to a horrible stench.

When nature is able to assert herself a distinct line of demarcation is formed within forty-eight hours, characterized by bright redness at the outer margin of the gangrenous tissues, separating the latter from the sound structures.

This is formed in every case capable of recovery, and more or less pronounced efforts at its formation are made in all cases except those from severe crushing injury. If the resistance to the gangrenous process is feeble red lines shoot out here and there and the line of demarcation is not perfectly formed. The process then quickly spreads into surrounding connective tissue, the products of decomposition finding their way into neighboring lymphatics, undermining the integument and developing large sphaceli. Unless amputation of the affected member checks the spread of the inflammation life is soon destroyed. In recoverable cases the line of demarcation becomes distinct and the protective barrier complete, only the gangrenous tissues being destroyed, these being thrown off by sloughing.

**Inflammatory Gangrene.**—Gangrene is occasionally seen as the result of intense inflammation. The red corpuscles are pressed from the vessels by sluggishness of the circulation in the capillaries, a pronounced degree of congestion being followed by total stasis, which, in severe cases, produces death by strangulation. It is not believed this result would usually attend were it not for the poisonous action of bacteria and their toxins. This form of gangrene is seen as a result of and in association with furuncles, carbuncles and similar inflammatory conditions when non-diabetic. When gangrene threatens the inflamed area becomes darker than usual in color, even livid in hue, mottled, and finally purplish and black. The tumefaction of surrounding tissues is pronounced, owing to the fact that they are distended with gas and decomposing liquids. Red and blue lines are seen along the course of the veins and lymphatics, and adjacent lymphatic glands are swollen and tender. The soft tissues of the gangrenous area are macerated, the bone being denuded and surrounded by putrid liquid in which pus is commingled. The general systemic picture is that of profound septicemia with severe physical prostration and visceral congestion and infiltration. Gangrene of this character follows upon poisoned wounds, and is too frequently the result of simple wounds by gross carelessness on the part of the patient or nurse or by means of primary infection from the instrument that caused injury.

**Traumatic Gangrene.**—Traumatic gangrene is due to injury of large blood vessels by gun-shot wounds or stab wounds; it may result from complication depending upon fractures, is seen as a result of local bruising or crushing of the tissues, as already stated, may occur from obstruction of the circulation by pressure from bandages or other surgical dressing and may be dependent upon strangulation of the tissues, as in hernia, paraphimosis, and where any local swelling is so intense as to cause tumefaction and obliterate the circulation. The sloughing of flaps after amputation, or in association with plastic operations, comes under the general classification of traumatic gangrene. Traumatic gangrene is always of the moist

variety and if the sloughing part is exposed to the atmosphere putrefaction is present to such degree that it is almost unbearable.

**SYMPTOMS AND COURSE.** The circulation of blood in the injured area is more or less severely impaired, depending upon the nature and extent of the injury. The limb is blanched and colder than its fellow, or if the gangrenous condition is circumscribed the tissues involved are colder than those surrounding. Pain is present as an initial symptom, and in a degree that corresponds to the extent of the injury. As gangrene sets in the pain subsides. If the injury be of the foot or hand it may still be possible for the patient to move them, and thus the gravity of the situation will not be understood. Discoloration is generally seen within twenty-four hours, but if the injury has been severe there may be such a degree of ecchymosis as to be deceptive. The distribution of color is irregular (Fig. 2, Plate II). At first pale, there will next be seen livid spots and inflammatory colors, with here and there specklings due to the settling of blood in the tissues. As decomposition sets in a greenish hue is added to the colors already present, and as it progresses this becomes dark and eventually black. When greenish discoloration appears the affected part becomes swollen, and, if not already so, becomes soft and of pulpy consistency. Owing to the presence of gases in the tissues, crepitus and an emphysematous feeling are imparted to the touch. Large blisters form, there is loss of sensation and in pronounced cases considerable areas of gangrenous tissue can be removed by the scalpel and scissors without complaint from the patient. If traumatism is not severe and the gangrenous area is limited in extent the bright line of demarcation peculiar to this condition will be seen surrounding the characteristic greenish surfaces. But if the vitality of the patient be low, or if the injury be unusually severe, this line may fail to show itself and there will be gradual infiltration and edema of adjacent tissues with spread of the gangrene therein. The color deepens in hue as the disease progresses and eventually becomes dark moss-green, or of an intermingled darkish-green and blackish hue. As the gangrenous state proceeds the soft tissues fairly melt away before it and are discharged as an ichorous liquid, exceedingly offensive and more or less irritating. Firmer structures, as tendons and muscular aponeuroses, are slower to yield to the destruction going on.

**Spreading Traumatic Gangrene.**—The severest accompaniments of this form of gangrene are met with in connection with compound fractures. In this there are severe extravasation, decomposition of soft structures and even bone, and the cellular spaces surrounding the wound are open, with no protecting barrier of lymph. (Moullin.) Decomposition ensues rapidly under the influence of high temperature, the limb swelling quickly, the skin becoming red, hard and dense, and the cellular tissues along the great vessels becoming boggy and edematous. The inflammation spreads to the tissues along the site of the injury, growing dull and livid, the cuticle separating from the tissue below and quickly decomposing. This type of gangrene very properly bears the name of gangrene foudroyante, or fulminating gangrene.

The spread of gangrene into uninjured tissues is due to a combination of chemical toxins and micro-organisms. The streptococcus, the bacillus of malignant edema, and saprogenic organisms are in part responsible for its spread. Gases which consist of ammonia, ammoniac sulphide,

sulphuretted hydrogen and volatile fatty acids spread through the loose connective tissue in advance of the disease, while leucin, tyrosin, fat crystals, crystals of triple phosphates and clumps of dark pigment are found in the foul fluids that are exuded from the wound. (Warren.)

**Hospital Gangrene.**—Hospital gangrene is of contagious origin developed by inoculation and through means of surgical instruments, appliances and dressings, by nurses, and from patient to patient where men are crowded together in unsanitary quarters, on the battlefield, in prisons, on warships and in other contracted and illy-ventilated premises. In early surgical times hospital gangrene was one of the most destructive of surgical diseases; at the present time, however, with our better knowledge of etiology, it is preventable and should never be seen except under the most unfavorable circumstances. It may develop from the simplest wounds, and in the surgical wards of hospitals, prisons and camps take on the most malignant aspect. In the milder forms the course of the disease is sub-acute, with little destruction of the tissues and not very profound constitutional disturbance. Hemorrhage may occur as the disease progresses from destruction of the blood-vessels, and as the larger nerves are attacked the pain is agonizing and the systemic shock severe. The destructive process goes on in the connective tissues under the skin until these give way and collapse, former areas of inflammation quickly becoming necrotic, with extensive sphacelus as a result.

The constitutional symptoms are profound, the patient is entirely prostrated and colliquative sweats and diarrhea are seen. Death may result from extensive hemorrhage, from profound systemic shock, or from general depression of the vital forces without the characteristics of shock, the patient sinking rapidly from sepsis that simply overwhelms the whole system.

Malignant hospital gangrene also comes under the classification of gangrene fulminans, or "*gangrene foudroyante*" of the French.

**Noma.**—Noma is a gangrenous stomatitis that affects the mouth and cheeks (Fig. 1, Plate III). It is seen as a complication of an exanthemata in children, and, very rarely, occurs apparently idiopathically. It is thought to be due to septic inflammation, but is also held to be of neurotic origin. The cheek is the part affected and the destruction may be so extensive that one side of the mouth will be completely exposed. Commencing as a case of malignant stomatitis the inflammation spreads, the cheek undergoes ulceration, and from a central speck gangrenous sloughing occurs, extending rapidly over the entire cheek even to the eye and *alæ nasi*. In severe cases both the superior and inferior maxillæ may be uncovered by destruction of the cheeks and lips and sections of the bone separate and fall away, carrying with them numbers of teeth. The edges of the ulcer are sharply defined and if the patient recovers dense cicatrices form around its edges, leaving an irregular opening that requires plastic operation for its relief.

Noma also affects the vulva, beginning at the labial margin and extending to the clitoris, nymphæ and hymen. In severe cases it may spread to the anus, destroying the perineum and extending to the thighs.

The subjects of noma are usually children of enfeebled constitutions, the immediate exciting cause of the gangrene being diphtheria, severe mercurialization or erysipelas, especially the former. Noma of the vulva may follow pudendal diphtheria in the parturient subject.



## CHAPTER VI.

### TREATMENT OF GANGRENE.

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**General Considerations.**—The treatment of gangrene will depend upon its variety and, no matter what the type, combines local and constitutional measures. The general depression is always profound, the system being debilitated and unresisting even in mild forms of sphacelus. In fulminating gangrene from injuries there is little disturbance in the nutrition, but the nerve-shock is usually severe and the vital functions are more or less depressed from this cause. Gangrene occurring from diseases of the heart and arteries, from diabetes, stomatitis, the severe fevers of childhood, typhoid fever, typhus fever, and smallpox, as also from erysipelas, requires constitutional measures, the general system being severely taxed from the conditions that render gangrene possible. The strength must be supported and the circulation assisted in every way possible. Concentrated nourishment, the best obtainable hygienic surroundings and supportive constitutional treatment are demanded. It has been the practice in gangrene from arterial disease occurring in enfeebled systems to support the system by alcohol, but it is believed better success will follow upon the exhibition of a sustaining diet of concentrated liquid nourishment. In exceptional cases considerable quantities of stimulants, especially brandy, are well borne. The affected member should be kept at an equable temperature. The recumbent position should be insisted upon as allowing of more ready circulation of the blood; but it is sometimes desirable to avoid the continued trauma of the dorsal decubitus.

The gangrene of diabetes will require strict diabetic diet and treatment, in addition to the measures directed toward the cure of the local state. Especially important is diet, from which should be eliminated, in so far as is possible, all starchy and saccharine foods.

Noma demands careful constitutional measures, as supportive diet, the best of hygiene, deep-acting constitutional remedies, and the local application of bromine, nitrate of silver or fuming nitric acid.

Bed-sores are usually seen in association with constitutional disease, and beyond the local measures that may be needed for the treatment of the individual ailment the constitutional treatment will be in general that demanded by the disease causing the surgical state, and the general supportive measures necessary in the treatment of all varieties of gangrene. Sluggish bed-sores are sometimes promptly healed by galvanism, by the positive pole.

Fulminating gangrene, whether occurring in an individual case from traumatism or occurring in camps or hospitals in epidemic form, demands support by diet and constitutional medication, at the same time requiring the most active local treatment suited to the necessities of the case.

**Local Treatment.**—Where possible gangrene should be prevented by the application of proper prophylaxis. This is not always possible, but when threatening from thrombosis or strangulation, as in hernia, or from compression and local stasis, as in extensive edema, the congestion may be overcome by incision and drainage. In phlegmonous erysipelas and cellulitis free incision in a number of directions may be necessary in order to secure relief from the extensive compression that is present. In bruised parts, and when the first symptoms of Raynaud's disease are seen, proper preventive measures may avert the gangrenous state, or at least modify it and assist in its prompt cure. In frost-bites cold applications will be required, the pack being continued until gradual restoration of the circulation appears.

Gangrene can be averted in severe injuries, as compound fractures and extensive crushing, in many instances by the removal of all wounded tissues, fragments of bone, ragged structures, and extraneous matter, especially if there be added the practice of careful antiseptic dressing and thorough drainage of the wound.

Prophylaxis having failed, attention will have to be directed to the oncoming gangrene. The circulation should be assisted in every possible way that the veins and lymphatics may empty themselves. The injured part must be kept warm by being wrapped in hot wool or cotton bandages investing the entire limb. At the injury and immediately surrounding it antiseptic dressings should be employed. Among the best of these are corrosive sublimate and iodoform. Boracic acid is not sufficiently active as a germicide, and carbolic acid, though sometimes useful, is more likely to be irritating to the healthy tissues. Absolute rest of the affected part should be insured, and that position maintained that will most perfectly encourage the easy circulation of blood in the part. Free drainage must be established. Retained fluids are certain to encourage gangrene. If necessary the local sore should be cleansed twice a day with peroxide of hydrogen, and subsequently covered with dry dressings. The wounded area may be lightly covered with a loose texture of iodoform-gauze, moist, or with similar mercurialized material. It is absolutely necessary to prevent decomposition and this can be accomplished by keeping the wound aseptic. When perfect asepsis cannot be obtained strict antiseptic measures must be instituted. The gangrenous part may be bathed with bichloride solution, one to five or ten thousand, or stronger; but if the deeper tissues are involved it may be necessary to resort to a milder antiseptic to avoid constitutional complications.

Dry gangrene will require absorbent dressings, as moist iodoform, moist corrosive sublimate-gauze, salicylic wool and other absorbent dressings. Under no circumstances should the dressings be excessively moist, nor should they be allowed to remain long in contact with the diseased tissues, it being necessary to retain the dryness of the parts in so far as is possible. The eschar of dry gangrene is so dense and hard that secretions are retained beneath it in some cases, thus setting up putrefaction and causing quick extension of the affection.

All dressings must be gently applied. Protecting granulations are thrown out by the tissues that still retain their vitality and these readily break down upon being handled, harsh manipulations resulting in their further destruction. For this reason it is necessary to avoid the use of

dressings that adhere too firmly to the wound, as charcoal, Fuller's earth, powdered clay, dry boric acid powder and other similar dressings. Lister's protective laid between the wound and its dressings will prevent the latter from adhering. Unnecessarily extensive washing of gangrenous wounds is harmful. The *sine qua non* is absolute cleanliness with the least degree of manipulation.

As sloughs are separated they should be removed, firmer portions being gradually dissected away with scalpel and scissors, the underlying sections being gently removed by means of absorbent wipers and peroxide of hydrogen. In gangrene from burns and other severe injuries tendinous and dense tissues are sometimes slow in coming away, their removal requiring much patience. It is especially desirable to avoid injuring adjacent tissues in efforts to secure their removal, as each new bleeding point affords a possible new site of infection.

**Radical Surgical Measures.**—Senile gangrene and diabetic gangrene of the extremities usually require amputation. In rare cases the spontaneous separation of a gangrenous toe occurs, with eventual cicatrization of the stump. In most cases, however, it will be found necessary to amputate at once. The site of amputation should be selected not so much with reference to leaving as much of the foot as possible as to be sure that the field of operation is in the healthy tissues. Haidenhain's statistics clearly prove the wisdom of high amputation in diabetic gangrene. In the senile variety it is equally desirable to select a site far removed from the gangrenous field. Hutchinson advises amputation at the lower portion of the thigh in both the inflammatory and dry forms of senile gangrene. The artery as seen in this site is small and wasted, and the flaps are usually well supplied with blood. If the gangrenous process be limited to the toes and tarsal portion of the foot the nearest adjacent healthy site should be selected; if the ankle and calf are attacked thigh operation is urgently demanded.

Traumatic gangrene requires the most radical surgical measures if life is to be saved. If gangrene sets in it is likely to spread quickly. Within twenty-four or forty-eight hours of its first appearance the entire leg or arm may be involved in the gangrenous process. It is not advisable to wait until nature makes effort at forming a line of demarcation. This is only permissible in slowly developing gangrene of limited area. A site should be selected some distance away from the local sore and immediate amputation at that point be performed.

Traumatic gangrene encouraged by constitutional impairment is less likely to be successfully treated by amputation. If due to the presence of toxins retained in the gangrenous extremity by compression of the circulation, from the extravasation that has occurred in the tissue at and near the site of the injury, high amputation may be successful; but if the gangrene spreads rapidly and no evidences are shown of the condition being circumscribed, amputation, even at a point remote from the site of the destructive process, is not likely to be attended by success.

**Medication.**—The practice of old-school surgeons in relation to medication is largely confined to stimulants, quinine, iron, and arsenic, all of which are administered in tonic doses and with the idea of guarding the system against septic infection. With the extensive toxination of the blood that is seen in malignant gangrene it may be that quinine and



brandy will be found temporarily beneficial; very little reliance is to be placed upon these measures, however, as a rule. Alcoholic saturation, if permissible at all, is only so in the case of overwhelming sepsis. And here it is doubtful if this or any other agent is likely to prove of benefit.

Arsenicum, whether administered in Fowler's solution by the old-school surgeon or in the low attenuations of the homeopathic surgeon, is more applicable to the systemic state that attends gangrene than perhaps any other single agent. The vital forces are prostrated, severe collapse is imminent, colliquative diarrhea and diaphoresis are present, the pulse is small, thready and rapid and the patient is sunken in a wave of sepsis that threatens his immediate extinction. The anxious apprehension, the thirst and the great depression of the vital forces are clear indications for arsenicum.

Lachesis is very like arsenicum, except that a greater degree of putridity of the wound is seen. Arsenicum is better suited to the dry and shriveling form of gangrene than lachesis, the latter having, however, the profound sepsis of the fulminating variety. The lachesis state is typhoid in character; the patient's mind is obtunded, the heart's action is irregular and feeble and there is absence of the evidences of collapse, the coldness of the surfaces, sweat and diarrhea of arsenicum. Lachesis, cro-talus and naja, the snake poisons, produce pronounced disorganization of the blood. The discharges from the wound are sanious and exceedingly putrid, and the appearance of the gangrenous sore is black, foul and disgusting.

Carbo vegetabilis has been recommended and used internally and externally in gangrene with success. Finely powdered willow-charcoal makes an excellent absorbent dressing, but only for superficial wounds from which it can be removed by washing. Internally the medium attenuations of this remedy have been found clinically useful in impending collapse of the vital forces from rapid shock. It will not be accounted a rival to arsenicum and lachesis in severe cases. Carbo is more especially needed in the moist variety in cachectic subjects whose vital forces are low. Colliquative diarrhea and collapse call for its exhibition.

Spurred-rye is known to produce gangrene in animals fed upon it, by causing spasm of the arterioles, and clinically secale has been found an excellent remedy in the dry forms of gangrene that depend upon contraction of the blood vessels. It seems also to be especially adaptable to gangrenous states occurring in connection with parturition.

Mercurius, nitric acid, phosphorus, bromium, and sulphuric acid may be required in the treatment of gangrene. Bromium is especially useful locally and internally in hospital gangrene and gangrene of the fulminating variety.

Sulphuric acid is a remedy for traumatic gangrene with blue spots occurring here and there with hemorrhage from gangrenous wounds. It is sometimes the best remedy for bed-sores.

Mercurius solubilis is more likely to be needed in gangrenous stomatitis that affects the lips, cheeks and gums. The glands of the neck are swollen and infiltrated and extensive salivation occurs. The gangrene extends to the bony tissues, especially to the maxillæ.

Already mentioned in connection with lachesis, cro-talus is a remedy of importance in association with characteristic debility, feeble pulse,

torpor of the mind, and general indifference. Gangrene occurring at the site of old cicatrices may require it.

During the inflammatory process that precedes and sometimes attends upon gangrene, aconite, belladonna, or ferrum phosphoricum may be needed as their respective symptomatologies are present. Senile gangrene sometimes has the general sepsis that may demand arsenicum. The affected parts are painful and exude a watery, fetid ichor. The tissues are hard, shining, and swollen, with burning vesicles on the surface.

Muriatic acid is called for in gangrenous ulcers of the lower extremities; the pulse is weak and slow, and the parts are generally edematous.

Diabetic gangrene may require phosphorus, argentum metallicum, mercurius corrosivus, uranium, phosphoric acid and silicia, together with the constitutional diet and hygiene that are absolutely necessary for the cure of diabetes.

Noma requires the same medication that belongs to gangrene showing elsewhere. Mercurius and phosphorus are especially applicable in stomatitis, though sulphuric acid, phosphoric acid, bromium, arsenicum, and carbo vegetabilis may be found useful in the course of the disease. Locally bromium and fuming nitric acid are recommended; it will doubtless be better, however, to treat the condition systemically and by the local application of antiseptics than by sharp escharotics.

## CHAPTER VII.

### SEPTICEMIA.

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**Definition.**—Septicemia is a poisoned state of the blood that is the result of the introduction of putrefying matter. It is an acute specific disease that is caused by the introduction into the blood of a micro-organism which multiplies rapidly in it and is differentiated from sapremia in the fact that it is more progressive and longer continued than the latter. While usually attended by the manifestations of septic fever, or by evidence of pyemia, thrombosis, embolism, or suppuration, yet it is not necessary that these symptoms shall be present. Post-mortem examinations following death from septicemia do not necessarily reveal pyemic abscesses, nor pleurisy, peritonitis, or other evidences of sapremia.

**Etiology.**—Septicemia is induced by the absorption by the blood of putrefactive liquids in which different organisms are entertained by different hosts and live upon the blood of the host. (Hamilton.) Sapremia, on the other hand, is due to the introduction of rotten or dead matter. Septicemia bears the same relation to surgical or traumatic fever that pyemia is known to bear to suppurative fever. Just as surgical fever is due to putrefying changes occurring before suppuration is established so septicemia is dependent upon septic infection of the wound which accompanies this process.

The present accurate knowledge of the surgical profession as to the factors that result in the establishment of septicemia is almost wholly dependent upon investigations made during the present century, and especially during the latter half. Gaspard was the first to obtain a disease resembling septicemia by injecting putrefying liquids into the tissues of animals. In 1850 the experiments of Davaine, whereby he demonstrated the presence of the anthrax bacillus in the blood of animals affected with splenic fever, started the profession toward its present accurate knowledge in the etiology of many of the surgical diseases. Investigations by Panam, a Danish observer, in 1856, resulted in the conclusion that bacteria are not the poisonous principle of septicemia but that the disease belongs to the domain of chemistry. Bergmann experimented with putrefied yeast and decomposed fluids and believed he obtained the active principle in the form of needle-like crystals, to which was given the name of sulphate of sepsin. Pasteur concluded that he had discovered the organism of production in his *vibrio septique*. He filtered blood containing the bacilli of anthrax through earthen cullenders, and animals inoculated with the filtrate were not infected. Siegel separated the vibrios from putrid fluid, developing a ptomaine-poisoning from the filtrate, thus showing it capable of provoking a species of blood-poisoning, though not genuine septicemia.

Other investigators are Coze, Feltz, Ogston and Koch. These, with others, have developed septicemia in animals by experiments with the blood of subjects who died of septicemia. Rosenback, Von Eisselberg, Gussenbar,



Vaughn, Neelson and other students in bacteriology have added to the knowledge on the question by their practical investigations. The subject is still an open one, however, and the exact causative factors are not yet fully comprehended and understood. The consensus of opinion gives more credit to ptomaine-poisoning than to bacterial infection. According to Neelson bacteria exist in the human system in septicemia but are not easily found. He assumes that a poison of great intensity has been thrown off by these organisms, thus bringing about the fatal result before they can multiply to any great extent. Vaughn inclines to the opinion that bacteria may produce a ptomaine by splitting up pre-existing and complex compounds in the body, and that different bacteria are capable of accomplishing this result, each developing its own characteristic poisoning. Baumgarten leans to the opinion that the toxine element predominates and exercises a poisonous influence that is fatal before the bacteria have an opportunity to multiply. Von Eisselberg claims to have been able to demonstrate the presence of staphylococci and streptococci in the blood of septic subjects, and Besser attributes the disease to the streptococci he found in the blood of four out of sixteen patients who died from traumatic septicemia. In seven out of fifteen cases they were present in the blood, and in sixteen out of eighteen cases were found in the organs.

**Infection.**—Septicemia is developed by infection at the site of a wound, and is now understood to be almost always the result of failure to practice thorough asepsis. Infection occurs most readily when sloughing and gangrenous tissue are present. It is associated also with erysipelas and hospital gangrene and may arise from putrefaction of the contents of a wound that are retained instead of being promptly cleansed away.

Infection may also occur through other channels. Lesions of the intestines, abrasions of the mucous membranes, injuries of bone and local inflammatory processes may afford channels of infection. Acute osteomyelitis occurring in the long bones of young subjects or those of enfeebled constitutions, attended by profound inflammation, is among the commonest causes of septicemia. It is presumed that infection by bacteria has occurred through the intestinal canal and that these have obtained lodgment at the site of some bruised or inflamed spot, and that the characteristic ptomaine-poisoning is the result of their effect upon the tissues. Infection may occur through the genito-urinary tract in either sex, especially the female; but it must be remembered that whether this or the respiratory tract or the site of a local inflammatory process be the point of infection the disease is everywhere the result of the same causes. Bacteria may have been introduced from without through abrasions of any of the tissues or by a disease-process, or they may develop at any of the above sites with ptomaine-poisoning as the direct effect of their presence.

**Symptoms and Course.**—Once the poison is introduced the initial symptom of septicemia is sharp rise of temperature, the thermometer rarely registering more than 103, and often not more than 101; there may or may not be a chill; it is generally absent, and even when present is not clearly defined, but consists more of repeated sensations of slight chilliness, intermingled with heat. There is headache, nausea, and vomiting, and sometimes diarrhea and active purging. The temperature

continues elevated and the patient quickly becomes anemic, the changes in the blood being marked. The chief change lies in the direction of the red corpuscles, this varying directly with the severity of the blood-poisoning. The onset of the disease is rather gradual, a period of incubation existing before the presence of the virus is felt. Occurring in connection with surgical operations it is not easy to differentiate between the initial fever of septicemia and the simple variety of surgical fever. The latter should begin to show amelioration at the end of forty-eight or seventy-two hours, whereas, if true septicemic fever is present the temperature remains high, or even increases, the wound shows puffiness or bogginess, its edges appear rather more red or darker than in healthy conditions and there may be evidences of inflammation at the side of the stitches. The prostration, headache, loss of appetite, mental hebetude, even to stupor, and the tendency of the bowels to relaxation—though this is not always present—suggest a close resemblance to the typhoid state. The temperature shows slight morning remissions and evening rise, yet the fever is essentially continuous.

The constitutional symptoms are not in proportion to the character of the wound. A very slight wound may result in septicemia, whereas the operation may have been an extensive one and but slight sepsis follow. There is generally more or less lymphangitis, the entire lymphatic system being affected; the spleen is enlarged and tender and should never be overlooked, this being one of the most pathognomonic symptoms of septicemia. Diarrhea is not an invariable symptom, but is present in a large proportion of cases. In unusual instances there may be acute gastroenteritis. This is more apt to be seen when the case assumes the enteric type. It is especially apt to occur from poisoning by canned meats, sausages, cheese and other putrefying foods. The liver is generally tender, and a slight discoloration of the skin is seen, with a yellowish tinge of the conjunctivæ. The discoloration is more dependent upon breaking down of red corpuscles than upon hectic icterus, the latter condition being oftener present in pyemia than septicemia.

The septicemic pulse is rapid, and in severe cases filiform. In unusually severe and long continued types paralysis of the heart terminates the case. When this danger threatens the pulse is weak and thready, irregular, and, perhaps, distinctly intermittent. The septic rash is one of the commoner symptoms of septicemia, and may vary in character from a simple erythema to a pustular, even hemorrhagic, eruption. It is not like the typhoid petechia, but more like the scarlet rash or rose rash. This redness of the skin is not present in all cases, but is seen in the more profound types of the disease and in persons of florid temperament or those predisposing to unhealthy skin.

A differentiating feature between true septicemia and the suppurative type of surgical fever is the enlargement of the spleen. While not essentially pathognomonic yet this condition is rarely observed in simple suppurative fever, while in true septicemia it is said to be always present. The more pronounced the sepsis the greater the enlargement and the severer the tenderness of the spleen.

While not especially significant in the milder types, and occasionally not in severer forms, yet in malignant manifestations of septicemia the wound becomes foul, even severely offensive; the odor is not as penetrating

as in moist gangrene but is quite characteristic. Heuter holds that a good surgeon ought to be able to make a diagnosis of septicemia by olfaction. When the wound becomes unhealthy the temperature tends to rise, the icterus is more marked, and the prostration of the patient is more profound. The facial expression is dull and listless. Bronchial symptoms, as bronchial cough, quickened respiration, and either unusual attacks of bronchial asthma or mild bronchorrhea are observed. If diarrhea comes on, as is likely, the stools are gushing and offensive. There is more or less meteorismic distension and borborygmus; the urine is concentrated and scanty and the breath has a peculiar sweetish odor that is held to be quite characteristic of septicemia; it has been described as the odor of new-mown hay. As the case progresses into the severe type the breath becomes offensive, even putrid. The tongue is heavily coated white at first, and later with a brown fur, in the severest types becoming dry and hard as in typhoid fever. The lymphatic glands, even in remote parts of the system, become enlarged and tender during the course of septicemia, those in the vicinity of the wound more especially so; the tissues immediately around the wound are inflamed and edematous, the capillaries are plugged with streptococci, and the walls of the larger vessels are infiltrated with them.

As the low typhoid state supervenes, beside the typhoid condition of the mouth and the meteorismic distension and colliquative diarrhea that are observed, the patient becomes more stupid and listless, a low muttering type of delirium comes on and he sinks into coma from which he does not recover.

**Diagnosis.**—The diagnosis of septicemia will depend in good part upon the condition of the wound and the association therewith of the sharp constitutional symptoms that have been described. If there be found only an accumulation of blood clot in the wound or a moderate degree of suppuration the clearing away of these may lead to recovery and thus exclude septicemia. If after the third day the fever continue, the patient become indifferent to his surroundings, and the stomach and bowels show derangement the case may be looked upon as suspicious. If examination of the spleen shows it to be enlarged and tender, and if examination of the urine reveals albumin and bacteria the diagnosis is clear. It is not always easy for the surgeon to determine the presence of septicemia. Many cases blend from the symptomatology of surgical or suppurative fever into confirmed septicemia without distinct recognizable differentiating symptoms. A sharp chill with quick rise of temperature to a height of 105 or 106 indicates pyemia. A moderate degree of fever with absence of chills, gastro-intestinal disturbance and splenic tenderness justifies the diagnosis of septicemia. The prompt subsidence of all the febrile symptoms upon opening and irrigating an unwholesome wound excludes septicemia.

**Prognosis.**—The prognosis of septicemia is always grave, but it varies according to the character of the case. Light cases which form, perhaps, the larger proportion now met with readily recover under proper treatment. Severe types are the cause of deep concern. Unusually high fever and colliquative diarrhea, profuse sweats, and a high grade of nervous symptoms are of grave omen. Metastatic abscesses complicate the case, retard recovery and lend additional dangers, though cases severely



complicated by metastases occasionally recover. The tendency of septicemia is toward a protracted course, dragging itself along over many weeks; it may even be months before a patient who has been severely ill from this disease, and who has had numerous metastatic complications, altogether recovers his former health.

**Morbid Anatomy.**—The systemic disturbances of fatal cases of septicemia are profound, though not very different from those belonging to other acute specific fevers. The brain and membranes are congested, the spleen enlarged, and there is apparent increase in the number of white blood corpuscles. If metastatic abscesses have occurred these may be seen in the brain, lungs, liver, kidneys, intestines or other organs. The kidneys may be generally engorged, the urine being loaded with albumin, blood corpuscles and casts. Embolic deposits, abscesses and hemorrhage are seen in the brain and pia mater. In more protracted cases petechiæ are seen in the skin and surface of the serous membranes, and occasionally evidences of endocarditis are present. In severely protracted cases there is extreme emaciation of all the tissues and organs, and there may be an occasional large abscess in some vital organ; or abscesses may be small and numerous, being found in almost every part of the body.

**Treatment.**—The treatment of septicemia has not been very satisfactory. Under old-school methods besides attempts to destroy the infection at the site of the wound, quinine, antipyrin, alcohol, ammonia, ether, and, later, corrosive sublimate and creosote have been administered internally. Locally, infected wounds are washed out with antiseptic solutions and, if necessary, curetted and then packed and drained. Sublimate solutions of one per cent. strength, carbolic acid solutions of five per cent. strength, and peroxide of hydrogen have been most relied upon. A combination of one part of iodoform, two parts of ether and eight parts of alcohol has also been used as a disinfecting wash, applied to all the crevices and recesses of the wound. The actual cautery, the galvanocautery, and Paquelin's thermo-cautery have been used for the destruction of the septic processes in wounds. A solution of nitrate of silver, twenty grains to the ounce, has been resorted to by the Ultzmann catheter in slow sepsis of months' duration located in the urethra.

Quinine has been given in five-grain doses every two to four hours, and the coal tar antipyretics have been resorted to for reduction of the temperature, stimulants being relied upon only when the pulse is flagging and the system depressed, opiates being called into requisition for pain. The chief reliances of the old-school surgeon have been a supportive diet, a liberal use of quinine and whiskey, chiefly the latter, inability of the patient to stand through alcoholic saturation being deplored.

It is well understood that these measures have been unsuccessful and that the consensus of surgical opinion is that the treatment of septicemia encompasses supportive diet by concentrated nourishment requiring the least effort for its digestion, the use of alcohol when absolutely demanded, and the selection of the remedy suited to the wants of the individual case. Arsenicum, lachesis, crotales, china, kali phosphoricum, phosphoric acid, rhus tox., hepar and silica may be demanded.

**MEDICATION.** Arsenicum corresponds more closely to the general picture of septicemia than perhaps any single remedy. The debility, weak heart action, enlarged and tender spleen, nausea, white-coated

tongue and diarrhea that are seen in cases of moderate severity are well covered by arsenicum. Its characteristic thirst and times of aggravation, afternoons and after midnight, added to the general arsenicum picture will prompt its use.

*Rhus tox.* is a remedy of value in septicemia assuming a low typhoid state. The muscular system is sore, there is meteorism, distension of the abdomen, colliquative diarrhea, dry tongue, sordes on the lips and teeth, and low muttering delirium.

*Hepar* will be demanded when the sore is in an unhealthy state, its secretions foul and offensive, and when the characteristic hectic flush and other symptoms belonging to this type of fever are present.

*Silicia* is especially indicated in protracted cases with sluggish abscesses and a continued tendency to suppuration. Septic abscesses of bone and periosteal inflammation from septic causes call for *silicia*.

*Lachesis* will be demanded in profound blood-poisoning states with weak, irregular heart action, and paralytic weakness of the left side. The tongue is brown and there is offensive diarrhea. The systemic prostration is so profound that the patient is scarcely able to breathe.

*Crotalus* is very much like *lachesis* in its symptomatology. The condition is one of profound blood-poisoning, there is nightly delirium, hematogenous jaundice, the face is yellow or leaden, the gums bleed, and the tongue is red, sore, and very dry and burning in the center. The stools are black, like coffee grounds, and very offensive. For septic haturia *crotalus* rivals *lachesis* and nitric acid. *Crotalus* is especially applicable to extreme lymphangitis occurring in association with septicemia, erysipelas or gangrene. The right side is affected rather than the left, although this remedy may be useful without reference to which side is involved.

*Carbo vegetabilis* will sometimes be beneficial in the collapse of severe septicemia, and if the gastro-intestinal disturbance is sufficiently profound *veratrum album* may be required. Carbolic acid in medium aqueous solution is an exceedingly valuable remedy in low typhoid states, no matter what the cause, and will be found to correspond to this type of septic fever. *Secale cornutum* is especially adapted to the sepsis that follows parturition. Phosphoric acid, phosphorus, and *kali phosphoricum* are applicable to extreme debility, and *china* will be found helpful when exhaustion follows upon prolonged suppuration or active septic diarrhea.

## CHAPTER VIII.

### PYEMIA.

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**Definition.**—Pyemia is an acute infective disorder, always accompanying suppuration, caused by the ordinary pyogenic micro-organisms, characterized by unusual acuteness of manifestation and sharp and well-defined clinical and pathological reflections. The generic significance of the word is “pus in the blood,” and it is universally conceded that instead of being a specific disease, due to a special organism, pyemia is but a complication of surgical states that are attended by suppuration. Unlike other special surgical diseases, as erysipelas, tetanus, or septicemia, it is not even a distinct disorder occupying a separate place among the surgical diseases. When the staphylococci and streptococci are observed in pyemia it is the product of these germs that causes suppuration, which, under favorable conditions, induces pyemia. As Moullin tersely expresses it, “If these organisms are rubbed into the skin so that the hair follicles are affected they cause boils. Under other circumstances where the sub-cutaneous tissue is especially dense they give rise to carbuncles; when the tissues are poisoned either by the products of septic decomposition or by the ptomaines of the snake-bite diffuse cellulitis follows; if syphilis is present phagedena may occur; if the body is poisoned by the inhalation of the exceedingly purulent substances thrown off by the lungs hospital gangrene and sloughing of the most extensive character are produced; and under certain conditions they give rise to pyemia.”

**History.**—The views of various observers in regard to the cause and nature of pyemia are interesting. Hippocrates described its characteristic symptoms, including the chills, jaundice, and other severe constitutional symptoms attending it. Paracelsus described its joint complications. Pare described abscess of the liver following upon bone fractures of the skull. Petit and Morgagni held that the metastatic abscesses that are observed in pyemia are caused by the actual presence of pus in the blood. Hunter brought out the fact that phlebitis is the important pathological condition found in the course of pyemia, and a connecting link between the causative factors and the metastatic abscesses and profound constitutional inflammation that are present in pyemia. Cruveilhier enunciated the problem that phlebitis was due to the coagulation of blood in the veins and not dependent upon the formation of pus by the inflamed lining membrane of the vein. Other observers, as Gaspard, in 1822, Rokitsansky, Virchow, Bennett, Pasteur, Sanderson, Doleris, Koch, Ogston, Heuter, and others as well, have contributed to the literature of the subject, and by careful investigations have assisted in solving the problem of pyemia until it is now quite well understood.

**Infection.**—Pyemia is most frequently observed in connection with injuries of parts possessed of large veins that are unable to collapse; hence the gravity of this disease in association with injuries of the skull



and the medulla of long bones. If diffuse inflammation of the cellular tissue occurs the connective tissues and lymphatics are responsible for the spread of micro-organisms, but in pyemia the blood is the channel through which the operating factors are carried. This accounts for the suddenness and violence of the symptoms of pyemia as differentiated from those of septicemia. If the cocci are retarded in their growth in the infected wound by being imbedded in connective tissue, or even in the lymphatics, there is not the rapidity of dissemination that occurs when they are carried directly into the blood volume. In pyemia they at once enter into veins that are not able to collapse, and coming in contact with their walls set up inflammation with resultant thrombo-phlebitis. Leucocytes become adherent to the rough places that are formed on the inner surface of the veins by the lodgment of the cocci thereon, a white thrombus being formed in this way. The blood plaques quickly adhere about these rough spots and coagulation follows. If complete occlusion of the vein ensues the barrier may serve to protect the system from further invasion. A thrombus of this kind affords fallow soil for the growth and development of micrococci, and infection and softening of the clot soon follow. When this occurs the separated particles of the "white thrombus of Zahn" are carried by the blood to other portions of the system, each fragment from the affected thrombi, when lodged in the capillary system of the lungs or in other organs, forming new foci of infection, thus becoming responsible for the formation of metastatic abscesses.

These fragments are changed with developing micrococci, which, having reached a stationary point, rapidly develop in the lumen of the vein or in the vessel wall, spreading throughout a considerable capillary area. Death of the tissue immediately surrounding the masses of micrococci follows, with suppuration at the border. When the destruction of these masses is complete this softens and a milliary abscess is the result. The more profound the systemic invasion and the more active the bacterial growth the more certainly will necrosis of the bacterial mass result.

Not only are pieces of thrombus carried in the veins to become lodged at the smaller bifurcations or in the capillaries, but free micrococci are carried in the blood volume to find lodgment quite remote from their starting point. The valves of the heart become affected by these masses, the bacteria lodging in the soft endothelium when the valves are closed. Small fragments of emboli are also lodged in the heart, and if these be of considerable size sudden death may ensue.

A diffuse form of pyemic inflammation known as pyemia simplex may occur from the free presence of micrococci in the blood without evidence of the existence of embolism; but the malignant types of pyemia are those in which thrombi form, with the development of large numbers of micro-organisms that are carried by embolic fragments to remote organs, there to set up metastatic abscesses in a manner to be described.

Another channel through which infection takes place is the lymphatic system. The anatomy of the lymphatic system, with its lymph vessels and enormous lymphatic glands, renders it a much less direct and free course of infection than the veins; but cases are reported in which the thoracic duct, the lymphatics of the sacral and lumbar regions, the lymphatics of the broad ligament, and this system in every portion of the

body, were laden with purulent material, no evidence of inflammation of the venous system being discovered.

Additional factors and influences that operate in pyemia are the development of pyrogenous substances that render pus that is formed in connection with inflammation of bone especially offensive to the human economy. Inefficient excretion of ptomaines generated in the alimentary canal when the kidneys are diseased are also to be considered as influential factors (Moullin). While not themselves productive of pyemia they may determine its outbreak and encourage its development in connection with other forms of suppurative inflammation.

**Abscesses.**—Pyemic abscesses are of two kinds—those that arise in connection with veins and capillaries and those that are embolic in origin. The former may be seen in the neighborhood of a wound or in remote portions of the system from lodgment of the micro-organisms circulating in the blood. Wherever seen the process and results are identical. The pus bacteria, having been developed in the wound, lodge upon the inner coat of the vessels and thrombosis sets up. The white corpuscles and leucocytes gather at this site, and as the micro-organisms pursue their destructive course a line of coagulation-necrosis is formed around them. Softening follows, the clot and the walls of the vessels and surrounding tissues at the site of the thrombus liquefy, and an irregular cavity is formed, filled with a thick oily pus, colored from the hemoglobin of the disintegrating tissues. In this form of abscess the suppuration is diffuse. There is no evidence of organization, the connective tissues between the muscles simply melting away, the pus burrowing among them, dissecting them from each other. If the neighborhood of a joint be the site of lodgment of the pus-bacteria that have developed in the original wound the synovial cavity or sheath of tendons in the immediate vicinity will be filled with pus in a very few hours. The inflammation attacking the cellular tissue in this type of pyemic abscess is not unlike the diffuse inflammation of phlegmonous erysipelas.

The embolic abscess results from the formation of thrombi in the veins; these being softened and torn loose by the pressure of the blood current are carried to remote organs, passing through the heart and into the blood vessels of the lungs. Fragments lodge here, causing metastatic abscesses of the pulmonary structure, while similar fragments are driven on in the blood current to lodge in the liver, kidneys, spleen or other tissue. Good-sized fragments block the veins at some point of bifurcation with the result that obliteration may follow. If the blood supply be entirely cut off serious consequences may ensue, as local anemia, gradual disintegration of the vessel at the site of the obstruction and gangrenous disintegration at the distal part separated by the obstructed vessel. If the collateral circulation be adequate to the nourishment of the local part no very bad result follows. When an embolus lodges in the lungs there may be extravasation of blood into the tissues, with coagulation of a considerable-sized clot, assuming a conical shape. This condition is observed not only in the lungs but in the spleen as well, and is known as hemorrhagic infarction.

**Infective Embolus.**—Should the embolus that is dislodged at the site of the original thrombus be infective, from the presence of pyogenic micro-organisms, necrosis of the infarct will follow. The entire

area surrounding the infection becomes softened and disintegrated, the central portion of the infarct liquefying, the whole forming a large area of suppuration. The disintegration is so rapid and the coagulation-necrosis so pronounced that when this result obtains the appearance is very like that of moist gangrene.

**Symptoms and Course.**—The symptoms of pyemia are those of acute infection. No surgical fever presents a more positive symptomatology. As systemic invasion occurs, an unusually sharp, even severe, rigor is seen. The chill may be preceded by fever, which, however, is not usually pronounced. This may come on insidiously, the temperature showing a varied range, sometimes being so slight as to cause the suggestion of the presence of a simple suppurative fever. After a few hours or a day or two of irregular fever with prostration, anxiety, lassitude and debility, an intense chill, commencing without warning, shakes, shatters and all but freezes the patient, the temperature quickly mounting to five, six, or seven degrees above normal. In severe cases the violent chill and intense fever which quickly follows it are soon succeeded by evidences of collapse, as profound prostration, severe diaphoresis and even colliquative diarrhea. In other cases the chill may be less pronounced and the fever less severe, rigors repeating themselves two or three times during twenty-four hours, or occurring with severity once a day. A peculiar feature is the intermingling of severe rigor with intense heat. While manifesting all the evidences of severe chill the temperature may be four, five or six degrees above normal. Repeated chills are accepted as evidence of recurring invasions, or the formation in different portions of the system of metastatic abscesses. As each new abscess forms other pyrogenous material is liberated, this poisoning the nerve centers controlling the regulation of the bodily temperature, with the result that repeated chills and considerable elevation of temperature are certain to follow.

The temperature curve of pyemia is quite characteristic. It more nearly approaches intermittent fever than any other type, but differs from all fevers in not having evening exacerbations and morning remissions with any degree of uniformity. It takes on the character of an irregular intermittent type. There is at first a sharp rise, when the thermometer registers its highest point. If the patient is already suffering from wound-fever when pyemia sets in the temperature will rise in sharp contrast to the scale which has been registering its aggravations. Then there will be a period of continued heat, extending over two, three or four days, when the temperature will fall to nearly normal. Within a few hours, however, exacerbations occur, the temperature climbing, with moderate recessions, until it reaches a point a degree or more higher than its first pronounced high point. It suddenly recedes to nearly normal and is then advanced again, this irregularity of rise and fall extending over a period of two, three, four or six days, according to the case, until it reaches its highest register. Variations occur frequently, sometimes several times a day, and if the temperature-range is to be called into requisition as a factor in diagnosis and prognosis an hourly or bi-hourly record should be kept. The pyemic curve consists of an irregular series of pronounced elevations and declines, with intermitting zig-zag movement. In occasional cases the temperature may fall to normal and



remain in that vicinity for a day or two, suddenly rising to its highest point as new and severe invasions occur.

The pulse and respirations vary with the temperature. The expression of the face is anxious, the more so as each rigor comes on. Pyemic jaundice is a characteristic symptom, the conjunctivæ being distinctly jaundiced, the face showing a peculiar earthy color, except in the severest types where it becomes distinctly icteric. The tongue is at first smooth and very red; later it becomes very much like the typhoid tongue and is covered with brown crusts with heavy white fur at the edges, or the entire surface of the tongue may be dark brown, even black. The teeth are covered with sordes, the mucous membrane of the mouth is in an unhealthy condition, in severe cases showing aphthous ulcers, and large hydroa form on the lips and at the corners of the mouth. The patient is severely prostrated and emaciates rapidly; in no surgical disease is the latter symptom more pronounced. The skin shows erythematous patches, petechiæ, and, in severe cases, purpuric spots. Hyperesthesia of the skin is occasionally observed, the patient being rendered exceedingly uncomfortable as his wounds are dressed. Bed-sores, and, in rare cases, vesicles and pustules, form upon the skin in various places.

A significant feature of pyemia lies in the fact that the brain is rarely beclouded, delirium, mutterings and unconsciousness not occurring unless the temperature is very high or unless the patient becomes severely exhausted and his brain anemic. The gastro-intestinal canal is often disturbed. Vomiting is nearly always seen, though not invariably so, as the rigors come on. Diarrhea is not usual, but is observed in pronounced cases in susceptible subjects.

**LOCAL SYMPTOMS.** Local symptoms arise during the course of pyemia, depending upon the tissues involved. Abscesses form in every part of the body. In some cases diffuse inflammation, with its attendant suffering, is the most characteristic observable symptom. Pleurisy, abscesses of the liver, empyema, pulmonary infarct with circumscribed pneumonia, metastatic abscess of the liver, kidneys and spleen, and of other organs, are also seen. These abscesses are invariably diffuse and are usually small. It is rare that a large abscess forms in the lung, nor is it often that this or other large organ is the site of severe suffering; the very smallness of the abscesses that are formed therein precluding the likelihood of severe pain.

**LIVER.** The jaundice that is characteristic of pyemia is not believed to be due so much to the presence of micrococcus growths in the capillaries of the skin as to a general hematogenous state.

**KIDNEYS.** The kidneys, as a rule, afford no positive evidence of the existence of pyemia. Albumin and fibrinous casts due to hyperemia of the kidneys are observed, and pus-corpuscles and bacteria are present in considerable quantities in some cases. Peptone, due to the breaking down of the corpuscles in the body, is to be found in the urine, and occasionally hematuria is observed. There is no distinct pathological lesion of the kidneys that renders a diagnosis of pyemia certain, all the phenomena described being due to effort on the part of the system to eliminate debris via these organs. The presence of peptone in the urine is believed to be due to the fact that the active leucocytes in pus possess the power to

retain this element so that it may be greatly increased in amount. (Hofmeister.)

**JOINTS.** When the joints are involved in the pyemic process there is complaint of pain in the knees and shoulders or other joints, the tissues surrounding are swollen and inflamed, and careful examination will reveal effusion. No joint of the human anatomy is exempt from liability to pyemic inflammation. The larger joints are especially prone to purulent synovitis. The knee joint or other large joint may become enormously distended with synovial fluid charged with turbid serum or pus within a few hours.

**CONNECTIVE TISSUES.** Phlegmonous inflammations are observed as an accompaniment of pyemia in the parturient woman. When this occurs the surrounding tissues are edematous and exceedingly infiltrated, the skin is dusky and brawny, and if suppuration of the subcutaneous tissue occurs large sloughs form and separate. If the deeper structures are involved necrosis of all the tissues undergoing phlegmonous inflammation, with extensive destruction and severe and protracted suppuration, is apt to follow.

**BONES.** Pyemic osteomyelitis of the long bones follows upon inflammation of the joints. Severe disintegration may follow, the medulla becoming dead, blackened and encysted. Abscess of the bones is sometimes followed by the formation of sequestra and the medullary cavity will be filled with a putrid mass of bone-debris, pus and bacteria.

**PYEMIC STATE.** The pyemic state is characterized by profound prostration, unusually rapid emaciation, abscess formation, secondary hemorrhage and, as the later stages of the disease are reached, delirium, coma, subsultus tendinum and metastatic meningeal inflammation, with its attendant paralytic, strabismic and aural disturbances. The usual course of the disease is from ten to fifteen days, though rare cases have been observed in which it has extended over several weeks. Billroth quotes ten cases lasting from twelve to eighteen weeks and Warren has seen a case lasting two months. The disease varies greatly in intensity. It may be fatal within a week. This result is especially likely to follow upon acute osteomyelitis. Death may also quickly ensue upon the occurrence of pericarditis, and in occasional cases an overwhelming wave of pyemia will carry the patient off in a few days by destructive exhaustion, emaciation and collapse.

**COMPLICATIONS.** This disease is one of complications and confusions. Ulcerative endocarditis is seen following upon inflammation of the lungs, kidneys or joints, the symptoms varying according to the disease of which embolism and metastasis are complications. (Warren.) Suppurative meningitis may follow upon or co-exist with metastatic pneumonia and endocarditis. In puerperal pyemia where the disease has been caused by feebleness in the contractions of the uterus and by retention of lochia the sinuses are not securely closed, thus affording entrance for the puerperal infection. Diphtheritic endometritis follows upon injuries to the lining tissues of the organ, and parametritis, ulcerative endocarditis and metastatic abscesses in various remote organs are almost certain to follow invasion by the lymphatic route.

Abscesses of the lungs are more frequently seen in the lower lobes. They are usually small in size, unless caused by the lodgment of an

embolic fragment, causing hemorrhagic effusion and the formation of conical infarcts, these breaking down in an abscess of the size of a Tanger orange or larger. Small metastatic abscesses may run together, resulting in abscesses of considerable size; but, as stated, the lung abscesses of pyemia are generally quite small and not easily detected. In rare cases a circumscribed catarrhal pneumonia is caused by the presence of an embolus in the lung. Effusion in the pleural cavity is frequently observed in phthisical subjects and strumous children. In rare cases purulent pleurisy with empyema is seen.

When the liver is the site of the pyemic abscess these may be the result of thrombosis of the pulmonary veins and may depend upon softening of thrombi in the portal system, or they may be caused by minute emboli which succeed in passing through the lungs only to lodge in the latter structure. The lungs are the most common site of the metastatic abscess of pyemia, the liver the next most common site, the kidneys coming third in order. The heart may suffer through endocarditis or pericarditis, or the mitral or aortic valve may be affected. Nodular growths form upon the valves from the lodgment thereupon of bacteria and white corpuscles as the valves are closed, these nodules forming focal points for ulcerations that destroy the endothelium and result in cardiac abscess.

No organ or tissue of the human body is really exempt from the secondary processes that are seen in pyemia. The disease is manifestly a secondary one, its chief pathological characteristics being the formation of abscesses in various structures of the body. The brain, the meninges, the bones and skin, as well as the organs more commonly affected, are liable to the development of pyemic abscesses. The lymphatic system is also a common site for its destructive processes. The parotid gland, the prostate, the thyroid, the testicles, the ovaries and the mediastinum have, in exceedingly rare cases, been the site of abscess-formation during pyemia.

**Diagnosis.**—The sudden chill and fever, the characteristically irregular, intermittent type of fever and the quick development of metastatic abscess, afford diagnostic signs of pyemia. Septicemia has more pronounced mental disturbance with greater depression. The headache is severe and in pronounced types delirium is early observed, coma and convulsions being also witnessed. In pyemia the mental state is not likely to be beclouded. If local infection from a recent wound be the cause of the pyemic condition its lips may be red and swollen, its interior discolored or grayish, and there may be an offensive and ichorous discharge from a foul and sloughing sore. The veins running from the wound are likely to be filled with softened clots, and the surrounding tissues are doughy and brownish. In rare cases the wound apparently is doing well. The pyemic wound is more likely to show suppuration, the septicemic would the appearance of sloughs.

**Prognosis.**—The prognosis of severe pyemia is grave, though it is by no means invariably fatal. Under present surgical methods the disease should never occur. Upon its initial symptoms it should be so promptly met by modern cleansing methods and constitutional treatment that its dangers shall be at once lessened. Surgical pyemia is very much more rare now than formerly—even recently—and fatality almost always



carries just censure with it. Puerperal pyemia is less likely to result fatally than surgical pyemia, especially when following upon injury to the bones of the skull and when seen in association with osteo-myelitis. Once fully established surgical pyemia is among the gravest of surgical diseases and, naturally, the more violent its early manifestations and the more numerous its secondary abscesses the greater the liability of a fatal issue. Unfavorable signs are unusually severe and repeated chills, followed by extreme elevations of temperature, profound prostration and rapid emaciation. Severe secondary symptoms are hemorrhage from various organs, extensive sloughing and recurring abscesses in the nobler organs.

**Treatment.**—**PROPHYLAXIS.** Proper antiseptic treatment of wounds as described in Section VIII will generally result in the prevention of pyemia, except in unusually severe traumatism involving large areas or, especially, in injuries involving bones plentifully supplied with blood vessels; and, excepting in severe internal wounds caused by infected instruments or foreign bodies, pyemia should be cured. The surgeon is not always responsible, however, for its existence. It is now most commonly seen in the surgery of emergency practice. Before the days of antiseptic surgery it was observed with equal frequency in the surgical operating room. In both classes of work the ventilation of the surgical room should be perfect, and the most thorough general and chemical cleanliness must be practiced. Prior to surgical procedure, and, especially in emergency practice, where the wound and surrounding tissue have been contaminated, the scientific application of the principles of antiseptic surgery must be applied. The surgeon, his instruments, all dressings, the attendants, in fact everything that is brought in contact with the patient, and especially with the wound, should be rendered thoroughly aseptic. The wound must be antisepticated, all fragments, shreds, torn particles, blood-clots, etc., etc., being promptly removed and the wound at once thoroughly treated to a course of chemical cleansing. Abscesses must be opened, suppurating joints emptied and cleansed, and fragments of bone that are diseased must be removed. In deep or ragged wounds the best possible measures for perfect drainage are demanded. Operative procedures completed, the site of the wound must be carefully closed and securely covered with a liberal application of sterilized gauze and other antiseptic dressing. The patient should be placed upon substantial nourishment and be given the very best of hygienic and sanitary advantages. Individual abscesses that have been opened should not only be drained but should be frequently cleansed with proper antiseptic solution, every effort being put forth to render the recesses of all cavities as aseptic as possible.

**GENERAL TREATMENT.** In old-school methods quinine and the coal-tar derivatives, salicylate of soda and other depressants have been used for the reduction of temperature. Quinine, iron and strychnia have been preferred for their tonic effects, and the various preparations of opium have been brought into requisition for the relief of pain and anxiety. Recent old-school surgical authorities are now condemning the administration of antipyretics because of their debilitating effect upon the heart (Warren), relying more especially upon quinine and alcohol, the latter being pronounced the surgeon's mainstay. In homeopathic practice greater benefits than are to be derived from these practices will follow upon the administration of arsenicum, carbolic acid, hepar sulphur, silica,

ferrum phosphoricum, kali phosphoricum, mercurius, and other well indicated remedies.

Arsenicum is, perhaps, nearer to a similimum than any other single remedy. It has the severe chill, the profound prostration, rapid emaciation, restlessness, apprehension and colliquative sweats of pyemia.

Aconite and ferrum phosphoricum will be required in the initial stage for the sharp chill, acute fever, restlessness, thirst and other symptoms belonging to severe disturbances of the heat centres.

Lachesis, crotales, kali phosphoricum, baptisia and rhus tox. carry in their pathogeneses the symptomatology of the profound infection of the typhoid state, and the profound symptoms of "blood poisoning" that go therewith are typical of pyemia.

Arsenicum, carbo vegetabilis, camphora and veratrum album will best meet the stage of collapse when it threatens or is on.

China, ferrum phosphoricum, arsenicum and nux vomica may be required to suit other stages of debility and prostration.

Hepar, silicia, kali muriaticum, calcarea sulphurica, arsenicum jodatum and mercurius are applicable to abscess formations in various organs and tissues.

Silicia and calcarea are especially to be thought of in connection with abscesses and injuries of the bony tissues.

## CHAPTER IX.

### TETANUS.

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**Definitive Considerations.**—Tetanus or lockjaw is a disease characterized by severe contractions of the voluntary muscles. The most common manifestations of tetanic contracture is trismus, or lockjaw, but any voluntary muscles may be involved in its contractions. General tetanus implies severe spasm of the entire muscular system.

Trismus nascentium was formerly supposed to be an idiopathic form of trismus, but it is now understood that it is invariably due to the bacillus of tetanus, generally introduced at the site of the navel. Tetanus following upon injury to the head is termed tetanus hydrophobicus. If the head is drawn backward the term opisthotonos is used. If the body is curved forward the name emprosthotonos is the one given, and if to one side pleurothotonos, or pleurosthotonos, is the term used to indicate the particular form the disorder takes. Emprosthotonos is rarely seen, and pleurothotonos is not a common manifestation of tetanus. Tetanus hydrophobicus is the more commonly observed form of tetanus, this name being given to the tetanic contractions of the muscles of the throat and jaw because these are always affected in convulsions arising from hydrophobia.

Tetanus manifests itself through the nervous system and may arise from a wound of the most trivial character. It is an exceedingly acute and fatal ailment, in many instances proving fatal within a few hours. A common cause of tetanus is injury to the palmar surface of the hand or foot. It is more likely to follow punctured wounds at these sites, especially if the wound is caused by an unclean instrument, than to occur in connection with the operative work of the surgeon. It is more commonly seen in connection with the ligature-operation for hemorrhoids than perhaps from any other surgical operation. It may occur from trivial causes, as from a trivial blow or injury to a nerve, a pin-prick, from insertion of the hypodermic needle, or other similar slight cause. It is also seen from nerve impingement when the trunk of a nerve is caught in a cicatrix, or impinged between a healing cicatrix and the end of a bone, following amputation.

**Etiology.**—It is now well understood that tetanus is due to the introduction into the system of the bacillus tetanus. This is a delicate rod, a little longer than the bacillus that is seen in septicemia in mice. It occurs in irregular masses in the affected tissue, and is recognized by the swelling at one end of the bacillus which shows an oval, sharply-defined, shining spore, enmeshed in the tissue. This spore formation shows in great abundance in artificial cultures and is also found in the blood of a tetanic subject. Cultures of the tetanus bacillus have a toxine which in very minute doses produces trismus and general tetanus in experiment-animals. Brieger claims also to have eliminated various tox-albumins possessing specific properties. The bacillus and spores of tetanus are so abundant and widely



disseminated in soil and dust as to be named ubiquitous. Especially are they common to the dust and rubbage of the street and barnyard. It would be supposed that the wide prevalence of this bacillus would make tetanus a very common ailment, and this would doubtless be the case but for the fact that its growth is prevented by the free access of oxygen.

Tetanus is especially common in Southern climates, and is among the common causes of death in the earlier years of infancy. In proportion to the entire number of fatal diseases it is an exceedingly rare ailment, but in proportion to the fatal surgical diseases it is much more common. It attends lacerated wounds, gun-shot injuries, punctured wounds, especially when the injury is inflicted by a rusty or dirty instrument, and may arise from an injury to a nerve through fracture or contusion in which there is no open wound. Exposure of a wounded surface to severe cold and an unhealthy state of a lacerated or burned wound predisposes to the development of the tetanus. It is more commonly seen in the negro and in the Latin races, and is also observed in domestic animals which are subject to the same injuries as man.

**Pathology.**—It has been held that tetanus is due to injury of the nervous system because it is through the medium of the nerves and spinal cord that its phenomena are manifested, and because it is the nervous system alone that has been found to show post-mortem changes invariably. It is now well understood, however, that it is an infectious disease, probably an infectious neuritis. Occurring in hospital practice, especially in army hospitals, it is possessed of a certain degree of contagion, passing from one patient to another. Verneuil has demonstrated that it is capable of transmission from horse to man. Flugge, Hocksinger, Nicotaiier, Reynier and other observers have discovered the specific bacillus of tetanus in the blood of tetanic subjects, and Brieger isolated three ptomaines called tetanin, tetanotoxine, and spasmotoxine. Vaillend and Vincent attribute tetanus to the effect of a poison secreted by a specific organism, holding that it is not a ptomaine. These observers look upon the disease as a mixed infection, contending that the bacillus of tetanus is inactive except in the presence of other organisms.

Observers who contend that tetanus is of neurotic nature cite the facts that it is known to occur in simple fractures where there has been no solution of surface continuity, that it is sometimes seen in an incised limb instead of first showing as trismus, and that evidences of nerve irritation, as swelling, hyperemia and cellular infiltration, are observed in the region of the wound.

On the other hand, those who favor the infectious theory contend that if tetanus were due to nerve irritation it would be a much more prevalent disease than it is, since injuries to nerves and traumatic nervous irritation are among the common disorders of the human system. They point also to the fact that tetanus is possessed of a definite stage of incubation, and to the further fact that it is often seen in the earlier days of infancy as a result of infective omphalitis.

The contention of observers who favor the infective theory seems possessed of the greater weight. The bacillus of tetanus is found especially in the immediate vicinity of the wound, and exists plentifully in the blood of the human subject where the disease is acute. It has been found in the spinal gray matter and medulla, and while not capable of

easy cultivation is yet cultivatable. Further proof that it is infective in nature is afforded in the fact that it is capable of being caused by hypodermic injections of earth, by transmission by particles of fragments of tissue, and washings from the wounds of tetanic subjects, by cultures obtained from a splinter of wood that has already caused tetanus, and by dust-infection. It is recited that of seventy persons injured in a church during an earthquake at Barjardo seven were attacked by tetanus, and that animals inoculated with dust from the same church died from tetanus.

Certain observers, as Verneuil and Larrey, are of the opinion that contact with horses or other domestic animals is a necessary factor in the production of tetanus. Larrey cites instances where the use of soiled straw taken from stables and used as bedding for wounded soldiers was followed by tetanus.

**Post-Mortem Appearances.**—The post-mortem appearances in tetanus are not those of destruction. In rare cases evidences of neuritis are found, and in two instances curious rounded points, visible to the naked eye, have been observed in the spinal cord and medulla. Dilation of the perivascular lymphatics in the brain has also been described. Congestion of the posterior horns and changes in the white matter of the cord are observed. The central and anterior parts of the gray matter in the case observed by Dickinson (Ashhurst) were most extensively affected in the side opposite to that of the injury. The essential alteration of tetanus consists of a large number of nuclei obtained from mutual compression, showing about the changes that occur in myelitis, being found in the posterior commissure of the gray matter of the cord. Lesions of the sympathetic nerve on the opposite side to that injured have been seen, but the general hydrophobic state and myelitic changes are not sufficiently characteristic to give to tetanus a distinct pathology.

**Symptoms and Course.**—Occasionally a feeling of general discomfort precedes the characteristic manifestations of tetanus for a few days, the period of incubation varying from a single day to two weeks. In most cases premonitory symptoms are rare. The first positive sign is a sense of stiffness accompanied by pain in the muscles of the jaw and neck. The patient complains of soreness and immobility of these tissues as from taking cold. This is quickly followed by inability to open the mouth to the fullest extent, and difficulty in mastication and deglutition. The pain is of a contracting nature, and is increased at each succeeding attempt to swallow or move the jaw. As the rigidity of the muscles of the neck becomes greater the head is thrown to one side or backward, usually the latter. The orbicularis oris partakes of the contraction in some cases, the lips are drawn apart, giving to the trismic subject the peculiar expression known as risus sardonicus. The facial expression is that of age, is anxious, painful and distorted. The opisthotonos increases until the head is thrown well back into the pillow, in extreme cases being thrown back to the shoulders. The muscles of the thorax become involved in the spasm, and the chest is fixed and immobile. The abdominal muscles are also convulsed and are hard, contracted and resisting. During the height of the disease the head is thrown backward so that the head and feet almost meet. The spasms are tetanic in character and are

aggravated paroxysmally, but are never altogether absent. When they come on in their most violent paroxysms the muscular cramps are so severe as to throw the patient about the bed violently and even to hurl him to the floor. The pain in the severe cramps of tetanus is agonizing, the respiration exceedingly rapid and shallow, and the forehead, and perhaps the whole system bathed with sweat. The pulse is small and feeble, and the facial expression is one of intense agony. During the acuter manifestations the temperature rises to 105 degrees, 106 degrees, or even 110 degrees. Wunderlich records a case in which the temperature registered 108 degrees before death and 113.5 degrees subsequently.

As tetanus progresses the reflex excitability is greatly increased. The slightest touch, jarring of the bed, even a current of air, is sometimes sufficient to induce a paroxysm of cramp. Beside his violent suffering the condition of the patient is rendered more deplorable by the dyspnea that is due to spasms of thorax, and to his inability to secure rest. In the severest manifestations of convulsions all the muscles of the trunk become hard and rigid. The thighs and legs are contracted or drawn widely apart, and the shoulders and arms are thrown out at right angles from the body. Paroxysmal attacks come on with most violent contractions, the face being distorted, the body rigid and twisted into every conceivable position with unusual violence, the limbs jerking wildly. In severest cases individual muscles are ruptured. Fractures of the small long bones occur in young subjects from the violence of the contractions. In male patients priapism is among the most agonizing symptoms. Retention of the urine, aphonia, injury of the tongue, lips and cheeks, and other local distresses add to the unhappy features of the case.

The patient is usually conscious to the last, though in some cases coma occurs some hours before death. Death may result from a paroxysm from apnea, or may follow from exhaustion. In some cases the heart fails. The patient is generally insomniac. His cries and expressions of agony and suffering during the severe paroxysms are heart-rending. No more distressing picture is witnessed by the surgeon than a violent case of tetanus.

**Diagnosis.**—Trismus is the distinctive feature of tetanus. Lock-jaw may occur from sore throat, synovitis, or rheumatism of the jaws, but in these conditions it is easily determined by local examination. Hysteria and hystero-epilepsy may give many of the manifestations of tetanus, as opisthotonos, retention of the urine, severe tetanic spasms, and risus sardonicus, but trismus is not often seen in hysteria. The spasms of hysteria are irregular, and through the intervals between convulsions there is subsidence of pain and complete subsidence of spasm; whereas, in tetanus the pain is constant and the spasms are never really absent, though aggravated in paroxysms. Cerebro-spinal and basilar meningitis have stiffness of the neck and opisthotonos, but scarcely ever trismus. They also sometimes have vomiting, headache, hyperesthesia and herpes which are not seen in tetanus, and are generally engrafted upon a constitutional history or are observed epidemically and without traumatism as a cause.

Hydrophobia is distinguished from tetanus by the fact that the spasms of hydrophobia are clonic and not tonic in character, and that the face is convulsed and restless without the rigid contractions that



give the peculiar sardonic grin of tetanus. Furthermore, delirium is a constant symptom in hydrophobia while it is exceedingly rare in tetanus. In hydrophobia there is also a peculiar psychical exaltation and anxiety, while in tetanus the physical agony is so severe that there is a corresponding degree of mental suffering without exaltation. It is necessary, moreover, to differentiate tetanus from strychnine poisoning, and this is not always easy. The essential points are that in tetanus there is a past history of a wound or an existing wound, and there is pain and a distinct period of incubation between the time of the injury—whether this be long or short—and the oncoming of convulsions. Whereas, in strychnine poisoning the spasms supervene at once. If particularly small quantities of the drug have been repeatedly administered over a period of time, to finally result in convulsions under cumulative dosage, the diagnosis is rendered more difficult. Tetanus begins with lockjaw and gradually descends. Except in children it rarely attacks the wrists and hands. Strychnine shows its first symptoms in irritation of the stomach and by affection of the long muscles, by preference those of the extremities. In tetanus the rigidity is persistent. In strychnine poisoning there are intervals of complete relaxation. During the spasms of strychnia the mouth may be easily opened, while between the general convulsions of tetanus it remains firmly closed. Strychnine poisoning terminates by death or quick recovery, while tetanus may drag along for days or weeks. Golding-Bird reports a case of a boy affected with tetanus who had spasms for fifty-one days with subsequent rigidity and death on the one hundred and seventh day.

**Prognosis.**—Tetanus is among the most fatal of surgical disorders. Death occurs in extreme cases a few hours after the first manifestation of convulsions. If the patient is able to survive the first four or five days his chances for recovery are somewhat increased. Tetanus occurring without traumatism as a cause and cases in which the disease comes on at a period remote from the injury are less severe and the prognosis is somewhat better. The more violent the course the more certain the fatality.

**Treatment.**—The treatment of tetanus resolves itself into constitutional and local. The latter implies careful attention to the wound, and especially so if radical operations upon nerves are to be performed.

**LOCAL TREATMENT.** The wound that is the cause of tetanus should be carefully cleared of all particles of dust, shreds of tissue, pent-up pus and other extraneous matter. The wound should be cleansed antiseptically, and, later, packed or thoroughly covered and carefully bandaged with iodoform or sublimated gauze or other antiseptic dressing. If the wound be punctured, lacerated or tortuous, peroxide of hydrogen may be required to thoroughly cleanse its recesses.

**NEUROTOMY.** Neurotomy is the operation that has been most relied upon for the relief of tetanus. Nerve stretching has been successfully resorted to in some cases. Ceccherelli tabulated forty-five cases of which fourteen were successful, twenty-nine were fatal, and two were doubtful. Ashhurst reports references to forty cases with but ten recoveries. Section of the affected nerve has also been resorted to but with doubtful success. Laurent has collected fifty-four cases of operation in which there were seven recoveries out of thirteen cases of neurotomy, eleven recoveries in seventeen cases of minor amputation, and eleven recoveries out of

twenty-four cases of major amputation. Letievant reports sixteen neurotomies with ten recoveries, and Knecht gives fifty-eight cases with twenty-eight deaths. It is observed, however, in this connection that the recoveries have usually been in chronic cases. Moullin remarks that nerve section and nerve stretching fail in acute cases where their help is needed.

Immediate local attention to an unhealthy wound is invariably demanded; even though it is doubtful if local or operative procedures are likely to be of benefit in the treatment of tetanus. If the wound is offensive and sloughing it should be carefully cleansed and antiseptically dressed. If altogether gangrenous it should be treated as a gangrenous wound. If tetanic symptoms appear early in the course of spreading traumatic inflammation immediate amputation of the affected part may be demanded, though if acute tetanus has set in it is doubtful if any severe operative procedure is justifiable.

**GENERAL TREATMENT.**—If possible the patient should be immobilized by being confined in a gutter splint, securely packed with suitable soft material and firmly bandaged therein, extreme muscular contractions being thus in part prevented. In hospital practice the continuous hot bath, the patient being kept immersed in water as hot as can be borne for hours at a time, is reported as being among the best general measures for tetanus. An objection to the use of the hot bath lies in the difficulty in keeping the patient in the bath-tub during his spasms; but if incased in blankets from head to foot, these securely bound around him, the bath can be administered by two strong attendants with comparative ease. The bath is unavailing unless it is continuous and as hot as can be borne, care being exercised not to inflict injury by the application of excessive heat.

Inhalations of chloroform or ether have been tried during the severity of the spasms, but with questionable success. Chloral and bromide of potash in large doses have been administered with equally unsatisfactory results. Opium is pronounced by Moullin and other conscientious observers to be of little, if any, benefit, and physostigma is but faintly praised. It is not believed that the older methods of treatment have anything to offer the homeopathic surgeon.

**MEDICATION.** The remedies that will be found most beneficial in the treatment of tetanus are strychnia, atropia or belladonna, gelsemium, cannabis indica, curare, rhus tox. and conium.

The spasms of strychnia are so very like those of tetanus that it is necessary to differentiate strychnia-poisoning from this disease. The face turns pale, a shudder passes through the whole frame, the countenance becomes ghastly, risus sardonicus is pronounced, and the body is thrown into general clonic convulsions, followed by tetanic rigidity with opisthotonos and trismus. There are pains like electric shocks flashing through the limbs. Strychnia is especially indicated where the spasms commence in the extremities, trismus quickly following.

Belladonna has trismus with painful contraction of the fauces, oppression of the chest, spasmodic contraction of the tongue, painful stiffness of the muscles of mastication, contraction of the eyes, rigid extension of the extremities, violent disturbance of the entire muscular system, and opisthotonos and pleurosthotonos. The spasms are aggravated by the

least noise or slightest contact. The patient sits upright, twitches, is unable to swallow and finally goes into severe spasms. Belladonna is especially applicable to the lockjaw of infancy and to cases occurring idiosyncratically.

Hypericum is a remedy of prime value in lacerated wounds involving the nerves. It is also indicated in injuries of the palms of the hands, as well as of the feet, or wherever a combination of injury of nerves and tendons is seen.

Stramonium has tetanic convulsions, violent motions of the limbs, oppression of the chest with extension of the arms and clinching of the hands. It is not likely to be indicated except in the milder forms of tetanus.

Tetanic spasms of the involuntary muscles, contraction of the throat, cramps in the stomach and bowels, with stiffness of the spine and legs characterize the action of physostigma, hence it should be useful in tetanus. In old-school practice doses up to four or four-and-a-half grains of the calabar bean have been used, but with unsatisfactory results as a rule.

In physiological doses *passiflora* has been used for trismus with *risus sardonicus*, *opisthotonos*, rigidity of the muscles of the neck and shoulders, and hard tense resistance of the muscles of the abdomen. It is given in full doses for the trismus of horses.

*Cuprum*, *cicuta*, *conium*, *veratrum viride*, *arnica*, hydrocyanic acid and *lachesis* may be required in individual cases of tetanus. As a rule *strychnia*, *belladonna*, *physostigma* and *hypericum* will be the remedies for acute manifestations. Other remedies that have been mentioned may be demanded in cases of sub-acute tetanus.



## CHAPTER X.

### RABIES.

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**Definition.**—Rabies, or hydrophobia, as it is more commonly known, is a disease produced by the specific poison from the saliva of an animal suffering from rabies. While more commonly caused by the bites of dogs it may also be caused by cats, horses, wolves, skunks and other animals. Rabies from herbivora is more rare than from carnivorous animals, but in the country it is not uncommon to see rabies from mad horses in whom the disease has been caused, presumably, by the bite of a dog. Almost any animal is susceptible to the virus of rabies. The disease has been seen in sick swine, domestic poultry, and, by inoculation, may be produced in guinea-pigs, rabbits, mice and other experiment-animals.

**Canine Rabies.**—A dog afflicted with rabies suffers a period of incubation of from one to two weeks after having been bitten by another rabid animal. In rare cases the incubative period extends from two to three months. As the disease begins to manifest itself the dog appears restless, is snappish, feverish and not disposed to obey. Its appetite is variable, it is irritable toward strangers and wanders about aimlessly, hiding in obscure places. At this stage the animal appreciates that he is ill and prefers to be let alone, or, perhaps, to seek the sympathy and caresses of his master, at the same time being disposed to lie in a secluded corner, growling and snarling whenever approached. Doleris mentions the case of a bull-terrier which was observed to peck like a hen at hay scattered about the floor of a stable. He was isolated and died of rabies. In some cases if the wound is recent and appears to annoy the animal it looks red and angry and swollen. After two or three days of this preliminary stage the dog becomes more fierce, snapping continually at imaginary objects, and it appears to be unwillingly impelled to snap and bite at every one who approaches. Its eyes are bloodshot, it has a fierce look, its hair is roughened and its tail hangs close to its body. While at first its food may have been taken as usual it soon becomes voracious in appetite and its taste may even be depraved, the animal refusing its regular meal and eating straw, rags and other refuse. Efforts at mastication are spasmodic. The rabid dog grasps eagerly at that which it desires to eat and tears it to pieces as though wishing to eat and at the same time desiring to destroy.

Up to this time the symptoms of hydrophobia, or dread of water, are not present. The animal is feverish and drinks greedily. The mouth is dry and the saliva which has been greater in abundance than normal becomes scant. In its efforts to dampen the fauces and quench its thirst the animal may sink its head into the water and drink greedily. The growl is husky and cross at first, subsequently becoming characteristically plaintive and baying. The sight of other animals, especially dogs, excites paroxysms of rage. Rabid animals will frequently run through a

crowded street passing numbers of men, children and horses to attack another dog.

As the disease progresses the hydrophobic symptoms begin. There is contraction of the muscles of the jaw and throat, with inability to swallow and increasing evidences of hallucination and delirium. The pupils are dilated, and the animal's expression becomes fierce, even intensely furious. He bites and snaps at every one, remaining silent and not barking noisily as does an angry non-rabid animal. Seeming to apprehend his danger the dog tries to escape, and if loose will run swiftly and aimlessly until he drops with exhaustion, seeming intent upon getting away from himself. As this stage comes on the animal is insensible to pain, and will grasp at a knife or other instrument, even a hot iron, and hang on to it viciously, chewing and biting at it as though wholly insensible to the suffering it would ordinarily cause. It is during the third stage of his mania that the danger from a rabid animal is greatest, although the moment the disease sets in his saliva is poisonous. The whole course of rabies extends over a period of six or eight days, unless the type be exceedingly severe, in which case two or three days may serve to produce a fatal result.

There is a type of rabies known as the "dumb variety" that is more common than the fierce form. The first stage is not different from that of the more intense variety, but in this dumb variety the animal's voice is altered from the start, whereas the change in the fiercer type occurs as the second stage sets in. In the dumb form the expression is that of a cowed or sane animal. The mouth is open, the tongue hangs protruded, paralysis of the rear extremities supervenes early, and death follows without severe or fierce symptoms. This type of rabies is not always recognized. The animal acts as though ill and sneaks off in a corner or some unapproachable place and dies without his disease being known. If the animal be unusually domesticated his illness excites sympathy and through their endeavors to relieve him or examine his mouth or throat to diagnose the affection attendants may be in danger of infection without efforts at biting on the part of the animal.

**Human Rabies.**—When seen in man the stages are about the same as in the dog. The wound may be red and irritable, becoming so within a few days or a few weeks after receiving the bite, or, perhaps it may be a year or more before hydrophobic symptoms are experienced. It is claimed that it may possess a period of incubation of ten years or longer. Authentic cases are reported in which the period of incubation in man has certainly extended over a year and a half. When developed in the human subject, however, hydrophobia is usually seen within two or three weeks or within a month or two after the rabid bite has been inflicted. The longer the subject goes without the hydrophobic symptoms after receiving the bite the less is his danger. The earlier the symptoms manifest themselves after the injury is inflicted the more violent are the manifestations likely to be.

The disease may appear in man in paralytic form, or as "dumb rabies" without the violent manifestations of hydrophobia, or it may occur in the fierce type, as in the dog, presenting the most distressing and heart-rending picture. The delirious variety, or frenzied type of hydrophobia is, unfortunately, more commonly observed in men and children.

**Etiology.**—The etiology of human rabies is not fully understood. Tol and Rivolta have recently described a coccus that they hold is the cause of rabies, but their observations lack confirmation. Pasteur and associates, who have devoted many years to the study and treatment of hydrophobia, have not yet been able to demonstrate any special form of bacteria as productive of rabies in man. The virus is probably chemical in character, and is always introduced into the system by inoculation. It is never absorbed into the blood but may gain access thereto through a solution of tissue continuity.

It has been supposed that rabies is more commonly seen in animals in extremely hot weather, and, therefore, that it is observed more frequently in the human species in the dog-days. This is an error. Numerous observers now hold that it is seen more frequently in the cold weather than in summer while the records of the Pasteur Institutes show that it is not confined to any season of the year.

While in man the bites of dogs are the most common causes of hydrophobia yet there is a difference in the degree of virulence of the bites of different animals. The skunk and wolf inflict a more dangerous form of rabies than the dog; the rabid hog is also an exceedingly dangerous animal.

**Symptoms and Course.**—The symptoms and course of rabies in the human subject are very like those of the dog. Perhaps the first symptoms observed are tenderness and annoyance about the scar. It becomes irritable and tingling sensations and twinges of pain are felt in it and radiating from it. As the symptoms are introduced the patient seems depressed, even melancholic. He is restless, anxious and apprehensive, perhaps without his mind reverting to the injury he has received. He is quite unlikely to direct attention to it if a long period of incubation has occurred; nor is attention likely to be called to the danger of hydrophobia if there are no unusual sensations about the scar. Insomnia, headache, mental and physical hebetude and a mild degree of irritability are apt to follow, extending over a period of two or three days. These premonitory symptoms may not be very pronounced and the first positive sign of oncoming rabies that is experienced may be a sense of constriction about the throat; or, perhaps, pains of a tearing character occur about the muscles of the neck, with pain in the back of the head. As pain is observed, if difficulty of swallowing is not already present, the muscles of the jaw show rigidity and contraction, and the patient finds himself unable to swallow readily. The contractions are not tonic, as in tetanus, but appear in successive, spasmodic convulsions from the neck and throat to the muscles of the chest, so that not only is there great difficulty in swallowing, but the throat becomes rigid, rendering respiration exceedingly difficult. As the second stage is ushered in with dysphagia and severe spasms—often provoked by the effort to swallow, especially the effort to swallow liquids, these giving this disease the name of hydrophobia—the symptoms are aggravated by the slightest motion or touch, even by draughts of air, the patient being excessively hyperesthetic. As in the dog, hallucinations are almost invariably present, and as the patient's intellect is not yet altogether beclouded he strikes, bites and fights constantly at imaginary objects and at those about him, becoming exceedingly violent in paroxysms, generally more or less completely conscious



of what he is doing, yet wholly unable to control himself. In individual instances the patient will, during a thoroughly lucid interval, warn his attendants of their danger at his hands and beg piteously to be restrained, even to be put to death in order that he may not injure his family and friends. The speech becomes altered later, though the human voice is rarely made to imitate the animal inflicting the injury, as is commonly believed. The tone is altered because of the constriction of the muscles of the neck and throat, and because of the dryness of the mucous membrane. It has been described as a peculiar, sobbing tone of voice. During this stage the pulse is small and frequently the saliva is viscid, hanging in strings from the mouth. The urine is scanty and the patient is intensely thirsty, but efforts at quenching his thirst almost invariably excite convulsions. In cases that are not characterized by premonitory symptoms it is the inability to drink and the spasmodic contractions of the muscles of the jaws and throat, coupled with the mental apprehension that attends these primary manifestations, that give the first warning of the oncoming of rabies. The spasm is especially limited to the muscles of respiration. They extend to the pharynx, chest, and secondarily to the extremities.

This second stage of hydrophobia lasts over a period of forty-eight to sixty hours. In unusually severe cases, continuing but a day or two, the patient dies in the frenzied convulsive period of the disease from asphyxia or heart failure. Generally, however, at the end of forty-eight or seventy-two hours the attacks begin to diminish in severity, gradually ceasing and the patient sinking in rapidly ascending paralysis. The convulsive attacks which characterized the second stage, and which were provoked by efforts at deglutition, muscular efforts generally or from touch, draughts of air, noises and other exciting causes, occur after twelve to fourteen hours independently of all disturbing influences. In many cases efforts to clear the throat and mouth of the viscid saliva that accumulates excite the convulsion, and as the patient becomes aware of this fact, he sits or lies with his mouth open, drooling constantly. In many instances it is the terror that the patient experiences that brings on his spasms. The consciousness of what he has just passed through and the dread of another attack operate as constant exciting causes, so that he passes from one paroxysm to another with but brief intervals between, until ascending paralysis or death from heart failure brings relief.

Occasionally during the height of the paroxysm the patient will suffer violent priapism, even to ejaculations. Acute mania attends very commonly in the fierce type, and the human subject, like the dog, will make violent efforts to escape, breaking away from attendants, forcing his way through a window or door, running like mad until fully exhausted or hurled to the ground in violent convulsions.

In the paralytic type of rabies there is not the furore of the active form. The paralytic variety is more likely to result from the infliction of deep and multiple bites. It is attended by malaise, headache, vomiting, and considerable rise of temperature. The pain in the wound is more severe than in the type previously described, and there is more apt to be numbness, edema and infiltration of adjacent tissues. This numbness increases until the parts in which it occurs are more or less paralyzed.

Sharp pains are felt in the muscles, and finally in the trunk and limbs, rectum, face, tongue, and, in fact, in every portion of the system, very pronounced in some portions and scarcely observable in others, paralysis of all the organs mentioned ensuing in the course of three or four days or weeks. Individual observers contend that many cases of acute paralysis that have been attributed to other causes are doubtless due to this type of dumb rabies; but it would seem that the association of deep and multiple injuries by animals would directly trace the cause of this form of paralysis in any given case. It is also held that "dumb rabies" may be seen in connection with meningitis and acute inflammatory brain disorders.

**Pathology.**—The phenomena of hydrophobic paroxysms, according to Gowers, are due to irritability of the respiratory centers, especially that portion that controls the process of extraordinary breathing.

First, the medulla oblongata, next the cerebral hemispheres, and, finally, the spinal cord are acted upon by the poison. The effect upon the medulla is most intense and most constant; the spinal cord is rarely affected until the last stage. The cerebral hemispheres are attacked in the later stages, the effects of the poison upon this portion of the brain being manifested by delirium. Curtis has likened the paroxysms of hydrophobia to attacks of periodic apnea due to temporary, partial or complete inhibition of the respiratory center, these occurring under the influence of peripheral impressions. The inhibitory stimulus probably proceeds from the area of distribution of the superior laryngeal nerve, being excited by attempts at drinking and swallowing accumulated saliva, or it may arise from the areas of the fifth pair of nerves from wetting the lips or face, or from fanning, or from direct draughts of air. In rare cases the inhibitory stimulus may arise from irritation to the nerves of sensation from the trunk or limbs, or from the nerves of special sense.

Gowers has found hyperemia of the gray substance of the cord without cell infiltration, the more intense pathological condition being observed in the region of the center of the medulla. Millitary abscesses were observed in the cervical cord and the veins were found distended with blood clots; the nerve cells had undergone little change though many of them were granular in appearance. The millitary abscesses which Gowers describes are composed of densely packed cells that have extended toward the peri-vascular sheath, infiltrating the adjacent tissues in which leucocytes are seen. The kidneys showed cloudy swelling in a case examined by Legg, but as a rule the abdominal viscera and thoracic organs are not pathologically disturbed.

**Prognosis.**—Hydrophobia is among the most fatal diseases of man. Moullin goes so far as to say that no authentic case of recovery, after the first symptoms have appeared, is known. Warren suggests that the treatment of the disease is futile, no authentic case of cure having ever been reported. When the phenomena of rabies have become established all treatment seems to be unavailing; but, fortunately, rabies does not invariably follow the bites of rabid animals. It has been estimated that but from fifteen to twenty per cent. of the bites of infected dogs result in the development of rabies. The bites of cats and skunks are more likely to result in hydrophobia than are dog bites. Worst of

all are the bites of rabid wolves. In Russia it is believed that hydrophobia invariably follows wounds made by rabid wolves, especially if they occur about the face and upper portion of the trunk. English authorities credit wolf bites with eighty per cent. of mortality.

The dangers are increased in proportion to the number and severity of the wounds, the quantity of virus introduced into the system having to do with the violence of the symptoms developed. The period of incubation varies, depending upon the rabidity of the animal inflicting the injury, the severity of the injuries inflicted, their location, the age of the patient and his receptivity. Children develop hydrophobia earlier than do adults. Wounds inflicted upon exposed parts of the body are more likely to result fatally than those inflicted on clothed portions, probably because in biting through the clothing less of the virus is introduced. It is even possible that the clothing will completely protect the individual attacked from salivary inoculation, even though severe teeth wounds be inflicted.

The danger of hydrophobia is decreased in direct proportion to the length of time which passes after the infliction of the injury. In other words, the greater length of time that lapses after a person is bitten the less likely is there to be hydrophobia, though, as has been stated, the period of incubation may last a year or perhaps longer.

**Treatment.**—The treatment of rabies in the human subject to be most effective must be prophylactic. When once a case of hydrophobia is well developed a fatal issue is almost certain. Prophylactic treatment consists of immediate attention to the wounds that have been inflicted and to the subsequent administration of antitoxine treatment according to the methods of Pasteur.

**IMMEDIATE TREATMENT.** If a person is seen immediately after being bitten a tight ligature should be thrown around the injured member above the wound. Bleeding from the wound should be encouraged as much as possible, if necessary fresh incisions being made for the purpose of exciting free flow of blood. Dry cupping is also useful in this connection. If the member is so situated that it is possible to perform complete excision of the wounded tissues this should be practiced; if not, thorough cauterization by nitrate of silver, the actual cautery, fuming nitric acid, or, better, crude carbolic acid should be resorted to. The practice of extracting the poison by sucking it out of the wound, as in the case of snake bites, is dangerous to the operator. The slightest abrasion of the mucous surfaces of the mouth may result in inoculation.

**PASTEUR'S METHODS.** The experiments and deductions of Pasteur in relation to the prevention of hydrophobia are highly interesting and worthy of reproduction. Pasteur found that the hydrophobic virus existed in the brain cells and in the saliva of the rabid animal, and by inoculating the trephined brain of a healthy animal with the brain matter of a rabid dog found that the period of incubation could be shortened. While ordinarily the symptoms of rabies would develop in from one to two months after the infliction of injury, in his experiments they appeared in from one to two weeks. From this fact he reached the conclusion, since definitely established, that the principal site of the virus is in the central nervous system. He found later that it existed throughout the entire nervous system of animals and in the salivary glands. For his experiments he



wisely chose the virus found in the cerebral matter as being purer and more intense than that existing in the saliva. His experiments demonstrate that a given virus is divergently modified by being passed through different species of animals. Inoculation of monkeys from their own species attenuates the virus, while inoculation of the virus of rabbits upon other rabbits results in increasing the strength of the virus. Virus resulting from one hundred and twenty-five successive inoculations produced hydrophobia in seven days, the spinal cords of experiment-animals being also made virulent throughout their entire substance. These are cut up and suspended in a dry atmosphere, and in time lose their virulence. By choosing the spinal tissue of different ages virus of the desired strength is obtained. In undertaking to make an animal refractory to the poison of rabies it is best to inoculate with a pulp made from a cord that has been dried so long that its virus is very feeble. As the experiments are continued a stronger cord, that is, a more recent specimen, is used from day to day, until finally gray matter is injected that is but a day or two old. In pursuing these investigations Pasteur found that dogs subsequently inoculated with very strong virus, the inoculations having been continued systematically from the weakest virus obtainable until the strongest virus had been used, were refractory to ordinary rabies and did not develop the disease upon being bitten by a mad dog.

Pasteur's methods of preparing the hydrophobic antitoxine are noteworthy. He removes the brain and spinal cord of rabbits from their bony casing under strict antiseptic precautions. The cords are dried by suspending them in bottles with a hole in the bottom for the admission of air. This aperture and the mouth of the bottle are closed with cotton wool plugs, the bottom of the flask being occupied by caustic potash to secure dryness of atmosphere. When dry the cords become brittle and darker in color than normal. The cord is chosen in preference to the medulla as being more convenient of manipulation. An emulsion is formed by heating fragments of the cord about the size of a pea with sterilized veal-broth or with water. This emulsion is placed in a conical glass covered with filter paper, dry nerve tissue is triturated by means of a glass rod and the broth is added, usually a thick turpid, until the quantity of half a spoonful is produced. When ready for the inoculation the experiment-animal is trephined and a drop or two of emulsion is placed beneath the dura mater. This process is gone through with with a large number of animals until the virus is obtained that is used upon the human species for the prevention of hydrophobia.

Before experimenting upon human subjects Pasteur had rendered fifty dogs immune, to his complete satisfaction. His first experiment upon a human subject was upon a child nine years of age who had been severely bitten on the hands, legs and thighs by a dog that was known to be rabid. Sixty days after the accident, July 6th, 1885, the child was inoculated in the right hypocondrium with half a syringe-full of the emulsion of the cord of a rabbit that had died June 21st. This cord had been suspended in a drying bottle for fifteen days. The next day the boy was injected with a fourteen-day cord, and twice each day was injected with cords of successive freshness until on the tenth day of his treatment he was injected with a cord one day old. The treatment proved successful,

the boy recovering. Experiments made with the preparation used in the treatment of this case developed rabies from five of the more recent cords that were used. The older cords did not produce the disease, but several of those used were proven to be virulent.

Pasteur follows two lines of treatment, one called the ordinary method, the other specified as the intensive treatment. The former consists of the more characteristic immunization by means of the use of fluids varying in strengths. In the intensive methods there is omission of the weaker and some of the intermediary cords and the shortening of the interval of inoculation. In the ordinary methods inoculations are given once in twenty-four hours, whereas in the intensive method the treatment is begun with a cord not more than ten days old, and a few hours after a cord is administered that is not more than eight days old. The next dose, six hours later, is from a cord six days old, and the fourth dose, again six hours later, is from a cord but four days old. If the case is desperate the inoculation is even carried further, and in extreme instances the virus of a single day's drying is used in the first twenty-four hours. Pasteur considers the ordinary treatment insufficient for the severe bites about the face and head, in those cases using the intensive treatment, giving three or four inoculations a day, administering a one-day-old cord on the third day. In the severest types three courses are given during a period of ten days.

The results of the Pasteur immunizing method show, for 1893, in which year one hundred and thirty-two patients, who were bitten by dogs that were shown by experimental inoculation to have had rabies were treated, that not a death occurred; twelve of these patients were bitten about the head, eighty of them on the hands, forty of them on the body and legs. Of ten hundred and eight patients treated who were bitten by animals declared by veterinary surgeons to be rabid but three died, a mortality of 3 per cent. Of five hundred and eight patients bitten by animals supposed to have been rabid one died, giving a mortality of 2 per cent.

**TIZZONI'S METHOD.** Tizzoni claims to have succeeded in rendering animals immune to hydrophobia by inoculation with the cords of infected animals that have been treated with peptones. An emulsion of the cord in peptones precipitates the virulent element in twenty-four hours. The flocculent deposit obtained is preserved in glycerine. His method is to obtain the blood serum of rabbits rendered immune to rabies by Pasteur's method, precipitating the serum by the use of ten times its volume of alcohol, the precipitate obtained being dried over sulphuric acid. A gramme of dried precipitate has been found sufficient to prevent an outbreak of rabies, eight days having passed from the time of the rabic inoculation when the precipitate was injected. Tizzoni's method and that of Centanni have not yet been applied to man.

**MEDICATION.** When an attack of hydrophobia is apprehended systemic prescribing is certainly demanded. While almost invariably fatal yet many of the most violent symptoms of hydrophobic paroxysms are capable of modification under carefully selected remedies. Strychninum, nux vomica, belladonna, stramonium, glonoinum, hyoseyamus and passiflora are deserving of trial.

Strychnia is more especially and effectually applicable to the tetanic form of convulsion that affects the muscles of the superior part of the chest, neck, and throat. The strychnia spasms are brought on

by draughts of air, touch, fright, and muscular movements, and while they most frequently commence in the limbs yet the symptoms are sometimes ushered in by initial spasms about the throat and neck. The spasms are violent, with severe muscular contraction, mental anguish, extreme rigidity of the throat and neck muscles.

The belladonna convulsion is greatly intensified by efforts at drinking or swallowing. There is hyperesthesia, intense congestion of the face and neck, extreme dryness of the mouth and throat, with viscid, sticky saliva. The eyes are injected, the patient snaps, snarls and bites in his mania. The delirium is pronounced, and in severe cases mania is extreme.

Glonoinum, more than belladonna, has violent congestion of the brain with intense headache, as though the head would burst; the face is alternately intensely flushed and extremely pale.

Stramonium ought to be found useful when the patient is intensely delirious and in the wild fury that belongs to the stage of excitement. The patient tries to get away, tearing things to pieces, is enraged and vehemently vicious and angry. Snaps, snarls, bites at everything.

Hyoscyamus has contraction of the throat, with inability to swallow. Unquenchable thirst, mental derangement, with occasional muttering and great mental anguish. Fever is a characteristic symptom. The patient tries to hide and moves about from one place to another. Severe trembling of the limbs, convulsive startings and muscular trembling characterize the action of hyoscyamus.

Tanacetum is more applicable to the dumb form of rabies with weakness of the legs and general prostration. The patient is voracious and depressed; spasms of the muscles of the larynx, pharynx, and thorax, occur with abundant salivation.

Other remedies that may be beneficial in special cases are gelsemium, passiflora, lachesis, cantharides, vipera, curare and crotalus. While the medication of hydrophobia patients is necessarily unsatisfactory and not very likely to be attended by benefit yet these unfortunate subjects should not be abandoned to their sufferings. In many instances it is possible to modify the severity of the spasms and relieve the mental anguish and apprehension that are among the more distressing features of the disease; especially if medication is commenced early, when the premonitory symptoms begin, it may be possible to give at least partial relief, even though a fatal issue follow.



## CHAPTER XI.

### LEPROSY.

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**Nature.**—Leprosy is a chronic affection chiefly involving the nerves and the skin. It is held to be a contagious disease, very chronic in its course, due to the influence of a special bacillus, its local manifestations being characterized by infiltration and destruction of tissue with disturbance and eventual destruction of sensibility, together with a slow, progressive marasmus. In former centuries it was considered the most dreaded disease of mankind. Lepers were isolated and shunned as incurable, dangerous to their fellows and objects of contumely. Leprosy was as loathsome and degrading two thousand years ago as syphilis is to-day. While its native habitat is the far East yet it has been seen in England, Scotland, extreme Northern countries, the Sandwich Islands, in both Indias, Palestine, Sweden, Turkey, along the shores of the Mediterranean and in some portions of the United States, cases having been seen in Michigan and Minnesota and, more especially, in Florida and Louisiana, the latter state particularly. Only this year a leprosy commission was created by the legislature of Louisiana to care for the lepers of that state.

**Etiology.**—Leprosy is accounted one of the diseases due to a specific bacillus. The disorder is closely allied to tuberculosis, and its micro-organism is very much like that of the last named disease. It is a long slender rod with somewhat shortened ends and without the power of motion. These organisms re-act to coloring re-agents in the same way as does the tubercle bacillus, though taking on the color more readily. They differ from the latter in that they are stainable in acids, eosine and fuchsin. They are cultivatable in gelatinized blood-serum and cooked egg.

Heredity does not seem to have any special causative relation to leprosy, nor is it affected by diet, climate, malaria or syphilis, except as these diseases tend to debilitate the system and thus render it less resistant to the infection.

While leprosy is held to be contagious and infectious this fact is sharply contradicted by the well-known fact that lepers live for years in close relationship with their families without others becoming infected. Philanthropically inclined individuals who have isolated themselves from the world by becoming nurses and attendants upon helpless lepers live in leper hovels a life-time without becoming infected. On the other hand, others who assume like duties occasionally contract the disease. It is not yet fully demonstrated that the lepra bacillus is the cause of leprosy, though it is shown to be constantly associated.

**Pathology.**—The force of the leprous process is spent upon the skin and nerves. The essential feature is the production of masses of granulation-tissue with giant-cells, round-cells, and intermediate varieties resulting from chronic irritation. The so-called lepra-cells are pro-

nounced leucocytes, connective tissue-corpuscles or epitheloid cells from the interior of the lymphatic capillaries transformed by the action of the bacillus. (Moullin.)

On the skin, especially of the face, knees, elbows, backs of the hands, tubercles are formed which slowly increase in size until the integument is so thickened and roughened as to assume the form of elephantiasis, sooner or later breaking down in ulceration. The destructive process extends slowly and invades deeper tissues and organs. The only portions of the system that seem to be entirely exempt from its ravages are the hairy scalp and glans penis. As the nerve tissue becomes attacked it is first irritated, then thickened, and finally destroyed. Trophic changes occur as degenerations that are white, dark, or even black, and pemphigus is among the most common expressions of the disease. As irritation is followed by ulceration the new granulation tissue that is formed is never well supplied with blood-vessels and wastes away, through caseation or development into dense fibroid tissues. The new particles break down, suppuration follows, and in severe cases extensive phagedenic ulceration with extensive destruction of the tissue is observed. In fatal cases the liver, spleen, kidneys and other organs are involved in the leprous process, or may be attacked by metastatic abscesses, septic in character. Granulations appear gradually in extreme cases and rarely the testicles are entirely destroyed.

**Symptoms and Course.**—Leprosy has a period of incubation that lasts from three to five years. When the disease is established its course may be said to last for a life-time. It occurs in two forms, the tubercular and anesthetic. The tubercular form is seen more commonly in temperate climates while the anesthetic varieties are observed more commonly in the tropics. As far as the effect of these two varieties upon the human system is concerned they are equally destructive to life and equally incurable. The tubercular variety seems to be more dependent upon the lepra bacillus as a cause.

In the tubercular form, as is to be expected, the skin and subcutaneous tissues are the primary site of the disease. Erythematous patches consisting of little nodules, tubercles and finally of considerable-sized masses, occur in successive crops. The initial symptoms are chilly sensations, slight fever, hyperesthesia and dusky red, highly-raised patches, which appear especially upon the face, but which may be seen also upon the forehead, arms, legs, hands and feet. These patches are sharply defined at their margin and when they disappear the skin is left pale, discolored and somewhat shriveled. The site of the hyperesthesia now becomes the site of anesthesia, though this is not general as in the anesthetic variety. When once started upon its course the leprous inflammation gradually progresses, though there may be distinct periods of remission. Individual spots disappear, leaving the skin somewhat atrophied at their site, while others break down and suppurate. When the tendency is toward elephantiasis the skin increases enormously in thickness and becomes rough and brawny, like the hide of an elephant. The lips, lids, and other portions of the face become hideously increased in size and occupied by great abscesses and masses of edematous tissue interspersed with scars. As the local disturbance becomes more pronounced the general health fails, the patient shows signs of nervous







Figure 1.  
Leprous Leukoderma.



Figure 2.  
Anesthetic Leprosy. New Lexington, Ohio.



Figure 3.  
Tuberculous Leprosy.



Figure 4.  
Leprous Ulcers.

PLATE IV.—VARIETIES OF LEPROSY.—HITT.

debility, becomes sexually impotent, the voice grows husky and aphonic, putrid discharges occur from the nose and ears, diarrhea is frequently observed, and in the more malignant types complete helplessness and abject imbecility follow.

The anesthetic variety is ushered in by about the same prodromata that are observed in the tuberculous form, excepting that patches of hyperesthesia with shooting pains and the development of small blisters upon the hands, forearms and legs are the earliest observable symptoms. The nerves are the site of the disease in this type. Careful examination of the forearm will often reveal an enlarged condition of the ulnar or median nerve. The skin of the fingers becomes red and glossy and as the nerve is affected there is muscular waste and shriveling of individual members. Later, scurfy spots appear upon the back, shoulders, and over the hands and lips. These are yellowish-white and dry with a raised margin that is hyperesthetic. The anesthesia extends as the nerve involvement progresses and the muscular wasting becomes more and more pronounced. Commencing at the scurfy spots already mentioned there is an extension of atrophy over almost the entire integument. The skin dries and withers and is of a pale leaden or light-yellow color.

As the disease progresses the joints become involved and are swollen and stiffened. Bullæ, from which hemorrhage is likely to occur, form upon exposed parts. Injuries sustained by leprous subjects readily become gangrenous, and individual members in which the nerve supply is cut off assume the dry form of gangrene. More frequently, however, the fingers and toes are shrunk until the nails rest upon the ends of the metacarpal bones, giving to the hands a peculiar claw-like appearance.

In rare cases the tubercular and anesthetic varieties of leprosy are combined. The face may be hideously deformed by tubercular leprosy of the integument, elephantine thickening, and great fibrinous bosses, the hands, arms, feet and legs being at the same time the site of the anesthetic or wasting variety, with the occasional development of tuberculous nodules thereon. A combination of local gangrene in tuberculous leprosy, with withering and atrophying of individual parts, makes an ugly picture. Small wonder is it that in olden times lepers were pronounced unclean and abandoned to their fate.

**Diagnosis.**—Leprosy need only be confounded with local tuberculosis and syphilis, nor is there a reasonable likelihood of confusion occurring here. The family history and general state of health of the tubercular subject, together with the cough, emaciation, hectic symptoms, and more acutely progressive character of the case will remove whatever doubt may have existed in studying the case. The previous existence of chancres and buboes, together with the characteristic syphiloderm and nodosities, falling of the hair and syphilitic sore throat, will serve to exclude a diagnosis of leprosy.

**Treatment.**—The treatment of leprosy is not yet systematized into success. Prophylaxis has consisted until very recent years of isolation of the leprous patient, even to total abandonment by family and friends. The degree of isolation that has been practiced throughout the centuries is altogether unnecessary. The disease is but feebly contagious, though directly infectious. If the excreted matter from the wounds or dressings that are used in connection therewith and all the excreta of the

patient be destroyed by cremation there is little likelihood of danger to attendants if reasonable care be exercised not to infect the system through abrasions or surface wounds. Leprous sores are not now believed to be more dangerous to the surgeon or nurse than the sores of syphilis. They should be dressed antiseptically whenever they become foul or unwholesome; in fact should not be allowed to become septic in nature. Local applications that may be useful are ichthyol, pyrogallie acid, arsenical solution, iodoform and mercuric bichloride. If local gangrene, leprosy in character, attacks an extremity amputation of individual members, as an entire foot or hand, may be required. It should be borne in mind, however that the condition is constitutional and that amputation secures no immunity from the development of the disease elsewhere. It should be practiced only where absolutely demanded because of the unwholesome condition of the part and the greater danger to life through its presence. Sloughing leprosy sores, spreading ulcers and degeneration of tuberculous warts and excrescences and leprosy gangrene require the local measures that belong to these conditions generally.

The tuberculous form of leprosy is best combated by profound constitutional remedies as arsenicum, graphites, lachesis, phosphorus, sepia, silicia, iodine, anacardium and sulphur. Unna claims to have cured cases with the internal administration of ichthyo-sulphate of soda and local applications of ichthyol and pyrogallie acid. Gurjin oil, 18-100ths gramme, in three grains of lime water twice daily, is reported to have established improvement, and chaulmoogra oil in perles, each containing three minims, the dose being gradually increased until the patient's limit of endurance is reached, is advised by Moullin.

**MEDICATION.** Arsenicum album should be useful as a constitutional remedy. It has the debility, foul sores, local gangrene, tuberculous patches, burning ulcers at the ends of the toes and fingers and an alternation of hyperesthesia and anesthesia. Unhealthy tubercles and nodules on the skin, with yellowish or whitish spots call for this remedy.

Iodine, especially in combination with arsenicum, is useful, generally in tuberculous inflammations of the skin and glandular system. In advanced cases of leprosy with enormous tuberculous patches, progressive emaciation, hectic symptoms and general debility the iodide of arsenic should be applicable.

Graphites is a skin remedy of first importance. It has coppery, annular, raised spots on the face, ears, buttocks and feet. Leprous spots with ulcers on the toes. Thick, swollen integument exuding sticky serum that gathers in yellow crusts. Unwholesome ulcers with infiltration of surrounding tissues are met by graphites.

Phosphorus is recommended in the late stages of the disease. There are thick patches on the face and arms, with tubercles on the trunk and buttocks. Brown spots are seen on an even base; pale spots with discolored borders. The fingers are tense and tender with anesthesia of their tips. The phosphorus cachexia predominates.

Sepia, more than any other remedy, presents the leprosy facial picture. The face is covered with tubercles, the forehead is swollen, the eyes are dull, red and weeping, there are tubercles and spots all over the body, and ulcers on the fingers and toes. The ears are swollen and pendant and discharge a thick yellow matter. Purulent eczema, the face







Figure 1. Leprosy Exedens.



Figure 2. Tuberculous Leprosy of Hip.

## PLATE V.—VARIETIES OF LEPROSY.—HITT.

being enormously swollen and disfigured. There are coppery colored tubercular spots all over the body, with tubercles on the face, trunk, buttocks and prepuce. The nails are unhealthy, with gangrenous ulcers of the fingers and toes.

Lachesis has leprous spots that may be yellow, red, greenish, lead-colored, pale or livid. Ulcers surrounded by nodules and vesicles, discoloration of the tissues, the muscles falling off in shreds from the patient.

Silicia has induration of the skin, especially of the face and hands. White spots on the cheeks; coppery spots and hard tubercles on the testicles and buttocks. Sloughing sores with copious discharge of pus and a generally unhealthy state of the skin.

As a basic remedy sulphur will be found beneficial in the tuberculous variety.

Anacardium is recommended in the anesthetic variety with profound anesthesia of the affected members, general weakness and prostration. Patches of raised and hardened skin on the face and arms, with numbness and a feeling as of pins and needles pricking the affected parts. Calotropis is recommended in the tubercular variety of leprosy, with lassitude and indifference, loss of energy and sensitiveness to touch over the whole body. Hydrocotyle has been advocated in leprosy by Andronin. This remedy has been given in appreciable doses for elephantiasis and true Asiatic leprosy. Petroleum, madura, natrum carbonicum, alumina and comocladia are also mentioned by Lilienthal as occasionally indicated in the treatment of leprosy.

Thorough local and general hygiene and sanitation must be practiced in leper camps and in the treatment of individual cases of leprosy. The system must be supported by nourishing diet, and perfect cleanliness and antiseptic attention to leprous wounds are required. For at best not much is to be hoped for in the way of success in the treatment of leprosy.



## CHAPTER XII.

### GLANDERS.

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**Classification.**—Glanders, or farcy, is an acute infectious disease characterized by the formation of nodules or ulcers in the mucous membrane and skin. It belongs to the horse and is communicable to man. It is seen in asses, mules, sheep, goats and rabbits but not in cattle. Virchow classed glanders with tuberculosis and syphilis under the general history of granulomata.

**Etiology.**—Glanders is due to a specific germ, the bacillus *Mallei*. These are small rods, somewhat shorter and thicker than the tubercle bacillus, and are usually found in pairs. The bacillus maintains its virulence under desiccation for about three months and is readily stained by alkaline analine dyes. It gains access to the human system through wounds and abrasions of the skin, especially at the corners of the nails. It also effects an entrance through the nasal mucous membranes, and is held by some observers to possess the power of infecting the respiratory and also the alimentary mucous membranes. The disease is disseminated through the lymph vessels and also through the blood vessels. The most common method of infection in the human being is inhaling into the mouth or nose the discharge of a sick animal under treatment. As is to be inferred, it is observed more commonly among those whose occupations bring them in contact with horses, especially with sick horses—hostlers, coachmen, drivers, stock-farmers and veterinary surgeons being most subject to it.

**Symptoms and Course.**—Glanders occurs in two types, an acute form which may prove fatal within three or four days, and a chronic variety which may last over many months.

In the acute variety there is a period of incubation which lasts from three to five days. In rare cases a period of from three to five weeks may be covered by the incubation period. When this is extended the case is more apt to pursue a chronic or sub-acute course. The initial symptoms of glanders are observed at the point of inoculation, as redness, swelling and pain, with prompt involvement of the lymphatics, which are swollen, with red lines extending from the point of infection to them, and indicative of accompanying lymphangitis. As its symptoms are observed there are constitutional evidences of infection, as chilly sensations, fever, headache, prostration, and ill-defined rheumatic pains, more especially in the neighborhood of the joints. The site of inoculation is soon surrounded by minute vesicles, which enlarge, become harder and eventually suppurate. In severe cases hard, red nodules form, varying in size from a pea to a walnut, looking somewhat like the eruption of smallpox, showing a softened center and turning into pustules, which, as pressed upon, discharge a thick and fetid pus. In slow cases the ulceration may become extensive, though the ulcer may eventually heal. It may be so deep as to expose the tendons and even the bones, the

process being so malignant that the deepest and foulest ulcers may form within forty-eight to seventy-two hours.

When the nose is the site of infection the affected nostril is painful and becomes swollen and inflamed; fetid, purulent matter is discharged, generally within twenty-four to forty-eight hours, and the nose and face become much swollen and inflamed. The mucous membranes of the mouth and fauces are involved, in severe cases the submaxillary and sublingual glands inflaming and suppurating, discharging externally. The respiratory tract may be affected, with resulting hoarse cough, profuse expectoration of fetid pus, and, in severe types, subsequent development of dyspnea. In some cases fever may be absent, but in the majority of instances it adds to the severity of the other symptoms. In malignant glanders the thermometer registers as high as 106 degrees within forty-eight or seventy-two hours of the appearance of the initial symptoms.

The chronic type is differentiated from the acute form by its less intense manifestations and its protracted course. Lacking the severity of infection of the acute type the chronic variety is differentiated by the wide distribution of the bacillus, chiefly by the lymphatics and nodules forming on the skin of the sub-cutaneous tissue, along the lymphatic vessels, and, later on, internal membranes. If the mucous membrane of the respiratory tract is affected it has the same purulent discharge, with its penetrating fetid odor, the nares being blocked with offensive crusts, and the same liability to gangrenous involvement at the root of the nose and in the nares that are seen in the acute variety. On the skin minute papules, which subsequently enlarge into nodular masses and pustules, form anywhere over the body, more especially upon the extremities. They are reddened, hardened, and inflamed at the base, and as they break down discharge sanguineous serum and pus. The affection appears to be superficial in mild cases, the eruption simulating smallpox, chicken pox or pemphigus.

The constitutional symptoms are less profound than in the acute variety, and as the disease progresses there appear symptoms of pyemia in the malignant type, the blood is quickly poisoned, the patient succumbing in the course of from five to ten days. In sub-acute cases constitutional prostration with delirium and coma supervene, death resulting in from three to four weeks. In the chronic type the disease is much more protracted and may drag out for weeks or months, the patient eventually recovering or death being finally caused by marasmus or chronic pyemia. Acute glanders from auto-infection may occur at any time in the course of the chronic form of the disease.

**Diagnosis.**—The diagnosis of glanders is not usually difficult, the disease being seen almost invariably in workers among horses suffering from the affection. The combination of nodular eruption, abscesses and ulcers of the skin, under the name of farcy, together with the characteristic putridity, ozena, and, perhaps, the general respiratory involvement, makes the diagnosis clear. The nodular swellings have only to be differentiated from syphilis, tubercular and pyemic abscesses. In each of these diseases the history of the case is clear. In the chronic variety of glanders when the history of the infection is not directly established the diagnosis may be made certain by the microscope and the recognition of the

bacillus Mallei. It may also be confirmed by inoculating goats or rabbits with the matter discharged from the human ulcer, or the discharges from the mucous membranes, inoculation developing glanders in the inoculated animal in from two to five days. Preusse recommends as a means of diagnosis the injection of Mallei which produces a peculiar febrile reaction in glanders.

**Prognosis.**—The prognosis in glanders is almost invariably bad in the acute variety, the disease usually terminating fatally in from one to three weeks. In the chronic form recovery occurs in about fifty per cent. of the cases. When the force of the disease is spent upon the integument and glandular system it is less fatal than when the respiratory tract is affected. Death may occur from gangrene of the nose, or from gangrenous sepsis at the root of the nose that results in convulsions. Death may occur from acute septicemia, from heart failure, from the bronchopneumonia of glanders, or eventually from extreme exhaustion and marasmus.

**Treatment.**—The treatment of glanders is very much like that of anthrax. If seen early the wound should be incised or cauterized freely with the actual cautery, carbolic acid or potassa fusa. If the nose be the site of the infection it should be thoroughly irrigated with a safe solution of mercury bichloride, dilute sulphurous acid, or solution of sulphate of sodium. Internal abscesses should be freely incised and curetted and their cavities packed with iodoform-gauze wet in a saturated solution of iodide of potassium. (Holmes.) If prompt attention be given to thoroughly sterilizing the original site of infection the patient may be saved.

The constitutional treatment of glanders is very like that of anthrax. Arsenicum, anthracinum, lachesis, crotalus, tarentula and remedies of this class will be required. Preusse has prepared an antitoxine called malleiu made from the blood and other viscera of animals that have undergone experimental inoculation with the virus, and has demonstrated that guinea-pigs and other small animals react to small doses. The preparation, which seems to have a therapeutic value, causes glanders in these animals. It has not been shown, however, that malleiu possesses therapeutic value in horses or man. It causes a slight reactionary fever in subjects of glanders, and is thus possessed of diagnostic value.

**PROPHYLAXIS.** All dumb animals suffering with glanders should be killed and cremated. The disease is rarely communicated from man to man, being almost invariably contracted from horses during efforts at their cure. It is not often observed in the human subject in this country. Six deaths from glanders in man were reported in Boston during the six years from 1885 to 1891 inclusive. Epidemics of glanders have been seen among horses in Georgia, Virginia, Texas, Pennsylvania, Louisiana, Minnesota, and the Indian Nation, and occasionally cases have been witnessed in other states. The degree of danger to the human subject that exists with efforts to treat animals suffering with glanders is so great that it is next to criminal to undertake a cure in the dumb brute because of the danger to man. All animals dying with glanders, and the dressings from wounds, as well as the discharges and excreta of the glanders subject, whether man or animal, should be cremated.



## CHAPTER XIII.

### ANTHRAX.

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**Synonyms.**—Anthrax has been known under various synonyms, as malignant pustule, splenic fever, charbon and carbuncle. In Germany it is known as Milzbrand, in England it is denominated splenic fever, and in the United States it is spoken of as malignant pustule. In France the term anthrax is applied to carbuncle and the term charbon is substituted for malignant pustule.

**Habitat.**—The disease does not prevail in the United States as in various parts of Europe, especially Russia, Hungary, France and Saxony. It is only occasionally seen in England and America. In countries in which it is observed it is sometimes seen as an epidemic. Domestic animals are more subject to its ravages than is man. The plague of murain mentioned in Genesis is believed to have been anthrax, and doubtless various severe epidemics of malignant pustule have been denominated the plague in former centuries.

**Etiology.**—Anthrax is due to infection by the bacillus anthracis, which is the largest and most easily recognized of the pathogenic organisms. It is observed with microscopic power in the blood of affected animals, being seen as a motionless rod of elongated, jointed cells from one to ten times as long as a red blood corpuscle. A striking peculiarity of this organism is the formation of spores in the presence of oxygen that have remarkable powers of resistance to the agents that ordinarily destroy bacteria. The spores do not form in the living animal, the bacillus here being reproduced by separation of the cells. Meat that is infected by the spores produces infection in man, while meat that is free of spores causes no infection. The bacillus possesses no unusual resistance but the spores are exceedingly tenacious of vitality. The anthrax bacillus is a saprophyte. It goes through with all its phases of development outside, and makes only accidental incursions into the body of man. (Whittaker.) It is conveyed to man by contact with a diseased animal or by the ingestion of diseased meat. San Domingo suffered a loss of fifteen thousand persons in six weeks in 1770 from infection through diseased meat.

Infection most commonly occurs by direct inoculation through abrasions of the skin. The disease in man is seen very commonly in those coming in contact with animals, especially the bovine species. Workers in factories in which the hair and hides of cattle are used contract anthrax, and butchers, stable boys, shepherds and veterinary physicians are attacked by it. Warren recites that the disease has been observed in the neighborhood of Boston among the operators in curled hair factories, and among longshoremen who handle hides imported from infected districts. The virus of anthrax may be communicated by flies. There is less danger of infection through the alimentary canal than the integument.

Contagion is not likely to occur from one human subject to another, though cases are reported in which personal infection has taken place.

Animals rarely contract the disease from each other, it being spread among them by flies and through the soil. It is especially common among animals in swampy districts and the poison may be conveyed by means of water which is passed beneath soil for a considerable distance. Stable utensils, fodder from infected fields and the moving of horses from an infected country to another are common causes of the spread of anthrax.

**Symptoms and Course.**—Anthrax has a short period of incubation. The disease may develop within a few hours after exposure or it may be a week or ten days before its symptoms are manifested. As a rule from one to three days covers the incubation stage. The first noticeable symptom is a sensation of itching or pricking that accompanies the presence of a small red speck or papilla, like a flea-bite, usually seen first upon the face. It may be that the local symptoms are so insignificant as not to excite attention and that the first observable symptom is profound constitutional depression, such as attends septic infection. This depression is likely to be followed by an irregular rise of temperature with shiverings and general bodily pains. The pulse becomes small, weak, and thready. Abdominal cramps, diarrhea and vomiting occur. The tissues of the glottis become edematous, and a greater or less degree of cyanosis is observed. In the most violent cases convulsions occur toward the end or the patient becomes delirious and comatose. In the more profoundly constitutional variety the patient sinks into a low typhoid state and hemorrhages occur from the mouth, nose and kidneys. Metastatic abscesses may form in different parts of the system as the disease progresses and there is precordial anxiety and intense dyspnea. Tetanic convulsions and lockjaw are seen to precede fatal coma. Death usually ensues from heart failure, or may result from asphyxia due to extreme edema of the glottis. Broncho-pneumonia and enteritis are more often observed when the infection occurs from the ingestion of poisoned meat, and in extreme cases from this cause the gastro-enteric and general constitutional symptoms take on the picture of acute poisoning.

The local manifestations of anthrax, commencing as the simple red spot like a flea-bite, are followed in from twelve to fifteen hours, by the formation of a small vesicle containing a brownish or bluish fluid. The surrounding skin is somewhat reddened, indurated and swollen. If the vesicle be not disturbed it dries and forms a crust. From the initial point of injury and infection an area of inflammation spreads, enlarging in depth and width. At the site of the vesicle there forms a small black eschar, at first superficial, but gradually involving the deep layers of the skin. Upon the site of the vesicle there is left a blackened central scurf which at first shows no signs of suppuration but around which effusion is seen to increase, the original area being surrounded by round after round of vesicles. There is also sharp burning sensation, but as the vesicle dries there is an absence of pain. The vesicles run together and their contents are more or less discolored, even to brownish black. The surrounding tissues are infiltrated and swollen, and as new vesicles dry the black eschar is increased in size. The infiltrating tissues surrounding it are brawny and edematous but not painful. The area of inflammation forms a considerable-sized circular tumor. If the neck be the site of the pustule considerable edema and infiltration, even to a dangerous degree of swelling, may

be observed. As the local gangrene starts, a line of demarcation forms around the eschar and the slough separates, leaving a granulating surface; in desperate cases extensive sloughing and gangrene are observed. In some cases the surface may cicatrize under the eschar without suppuration.

The favorite sites of malignant pustule are the exposed surfaces of the body, especially the face and neck, though the hands and shoulders are occasionally the site of anthrax sore, especially in men who work among hides without trunk-wear.

**Diagnosis.**—Malignant pustule is not easily confounded with other sores. The indurated, dusky base, the surrounding lines of vesicles, the wide-spread edema and the central black eschar make a sore that is unlike any other. The red papule with dark center is characteristic. From carbuncle it is to be diagnosed by the fact that anthrax spreads from a central point while carbuncle is the result of the coalescing of a number of points. Carbuncles appear more frequently on the back and trunk while anthrax is observed usually on the uncovered surfaces. Carbuncles are more frequently seen in persons of enfeebled constitution and advanced years, while malignant pustule is found in healthy, robust subjects. From erysipelas it is differentiated by the more superficial character of the inflammation and in the fact that no particular spot or nucleus is seen as the starting point of this inflammation.

When anthrax occurs from internal infection the diagnosis is difficult. The constitutional symptoms are sudden and profound, but are in no sense characteristic, and if unattended by a clear history of infection the nature of the disease is likely to remain in doubt. The microscope will make the diagnosis clear, no matter what type the disease assumes, the anthrax bacillus being readily observable under light power and being readily stainable.

**Prognosis.**—In external anthrax the prognosis is good. In the internal variety and where the system becomes generally infected from the local introduction of bacillus the prognosis is more unfavorable. When the disease appears in epidemic form from the wide-spread infection of cattle the mortality is large, and where there is more than one site of infection, as through the introduction of the bacillus by flies or upon numerous abrasions of the skin, the general sepsis that follows endangers life. The broncho-pneumonia and gastro-enteritis of anthrax are very much more severe than those in ordinary form, therefore the danger is greater when they arise from this cause.

**Treatment.**—Local treatment of anthrax, when the disease is seen early, is excision of the entire pustule if possible. If the systemic symptoms be not yet pronounced and the disease be confined to a local area complete excision removes the infection. This result is best accomplished by the scalpel. In individual cases it may suffice to cauterize the wound and to inject beneath the pustule a solution of carbolic acid, one part to twenty. It is well to make other incisions into the surrounding subcutaneous tissue for the purpose of establishing free drainage, and to thoroughly sterilize the infected area with mercuric bichloride or carbolic acid solution. Immediate cauterization of the wound is best accomplished by potassa fusa or the actual cautery. In general the attention to the local wound and to the pustule in its various stages of progression and degeneration is the same as is applicable to other malignant sores.



CONSTITUTIONAL TREATMENT. The constitutional treatment of anthrax embraces the administration of arsenicum, ferrum, lachesis, crotalus, naja, rhus tox., carbo vegetabilis, china, anthracinum and tarentula.

The arsenicum sore burns like fire. Its center is occupied by a red-dish-blue fluid, the center soon becoming gangrenous. The surrounding skin is blue, cold and dry, falling off in large scales. The pulse is weak and thready, the heart's action is feeble. The patient is anxious and apprehensive and suffers from nausea, colliquative diarrhea and the peculiar arsenicum restlessness, thirst and general exhaustion.

The lachesis sore discharges a dark, bloody pus. The skin is tense around it and the tissues are edematous, dark red and threaten gangrene. The ulcer burns intensely, chiefly at night. As the gangrenous process progresses the patient is exhausted and general lymphadenitis is observed.

China will be required where there is exhaustion of the vital forces with a low, putrid form of fever, painless diarrhea and alternation of fever and sweat.

Belladonna will be required for the phlegmonous inflammation that affects the surrounding tissues and neighboring glands and for the general erysipelatous inflammation that occasionally occurs in connection with anthrax, and that is attended by headache, delirium, constriction of the throat and convulsions.

Rhus tox. will be required for the vesication, burning and itching that is present in many cases. It is also to be thought of in the typhoid state that goes with anthrax.

Tarentula is applicable to cases occurring on the back, especially over the vertebral column and back of the neck. The pain is excruciating in character and intensely burning, worse at night, and so severe as to cause profound prostration.

Anthracinum is particularly recommended by Lilienthal for the infiltration of the cellular tissues with red lines following the course of the lymphatics. There is a discharge of ichorous, offensive pus from the pustule which becomes gangrenous. The pains are violently burning and are not relieved by arsenicum.

Ferrum, apis, hepar, silicia, naja, crotalus and bufo may be required in special cases.

Carbolic acid in the third or fourth aqueous solution is among the best remedies for anthrax and similar blood-poisoning wounds, when both constitutional and local symptoms are severe. The prostration is pronounced, the wound is offensive and unhealthy, gangrene menaces, the patient's mind is beclouded, low, muttering delirium supervenes, and coma and collapse threaten.

## CHAPTER XIV.

### ACTINOMYCOSIS.

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**Definition.**—Actinomycosis is a chronic inflammatory process that is seen in the lower animals and also in man in the form of a sarcoma-like tumor or growth that is due to the presence in the tissues of a vegetable parasite bearing the name actinomyces. In animals the disease is denominated lumpy jaw, and it is often confused with true sarcoma in the brute. In the human species actinomycosis is not infrequently accompanied by suppuration, due to the presence of pyogenic organisms. The peculiar fungus that is the chief characteristic of this affection is found about the jaws, throat and tongue of animals affected. The organism is about the size of a millet seed and consists of yellowish patches of tallowy consistency, composed of waxy threads and pear-shaped or clubbed prolongations arranged in groups, giving the growth the appearance of the sunflower, under the microscope. The presence of the fungus in man without associated suppuration is rare. The granules of the disease are observable to the naked eye or under a glass of light power.

Actinomycosis chiefly affects the domestic bovine. It has been thought that it is transmissible by the flesh of cattle and also by milk, but this view is not now generally held to be correct.

**Infection.**—The disease is characterized in the human subject by the formation of abscesses and the presence of the typical, yellow granules in the pus. If infection has taken place by the mouth the initial symptoms are those of toothache, swelling at the angle of the jaw, an unhealthy state of the gums, and difficulty in swallowing and opening the mouth. There is slight enlargement with redness and, finally, with softening and suppuration of an external tumor located about the angle of the jaw. The pus which discharges shows the yellow granules. Prior to the opening of the abscess the skin becomes deep red and the granular surface that follows upon suppuration is of a yellowish or violet color. The jaw is the part usually attacked.

Infection through the respiratory tract is thought to be due to the inhalation of colonies of actinomyces already formed in the mouth and throat. When the intestines are involved in the process it is due to the swelling of the organisms in the food. Infection also occurs through abrasions of the skin and mucous membranes, and at the site of surgical wounds.

**Symptoms and Course.**—Actinomycosis is a chronic ailment. The first symptom that is observed is, as a rule, the enlargement of the lower jaw. This sometimes manifests itself as an ill-defined swelling below the maxilla, the growth increasing slowly in size, gradually presenting as a tumor of the jaw. In other cases a painless nodule, reddish in color, formed upon the skin over the angle of the jaw, is the first observable sign. This grows slowly and at first does not involve the blood vessels nor the lymphatics. Later, however, the growth takes on

the appearance of a slowly-developing granulation tumor, with eventual suppuration. When this stage is reached there is acute pain, the growth rapidly increasing in size, the skin becoming red and husky, the surrounding tissues infiltrated and swollen, and constitutional symptoms, such as belong to infective cellulitis or diffuse inflammation of the bone, being manifested. From the local site infection takes place through the lymph channels and soon deposits in the form of caseous nodules, abscesses being found in the brain, lungs, liver, kidneys and other organs. These show the characteristic yellowish, sulphur-like, tallowy bodies about the size of a millet-seed that are the special feature of actinomycosis. When the disease reaches this stage its manifestations partake of the character of general septic infection, and its course is protracted or not dependent upon the virulence of the infection and its extent.

**Diagnosis.**—Actinomycosis, or “lumpy-jaw,” is diagnosed in cattle by its tumor-like growth and local site. In man the one certain diagnostic feature is its characteristic yellow, sulphur-like, millet-seed bodies, these radiating in stellate form from a common center. The teeth become loose and carious, and when extracted their cavities are filled with granulation tissue that breaks down into pus. The alveoli undergo disintegration and considerable masses of the maxilla may also be destroyed. In some cases it is difficult to diagnose this form of granulation growth from sarcoma of the jaw. There is nothing especially destructive in the condition at first, and it is only when the characteristic mycelium is found that certain diagnosis of actinomycosis is possible. The presence of the disease in cattle and man simultaneously would, of course, assist in determining its nature.

**Prognosis.**—Except in neglected cases, that are allowed to go on to suppuration and general systemic invasion, the prognosis is not grave. In unhealthy subjects where general infection has taken place the disease may drag out in chronic form over a number of years. If rapid dissemination of infection occur pyemia may develop and prove fatal. Especially is this termination probable when the vital organs are attacked by actinomycosis abscesses. Death may also occur from exhaustion from protracted suppuration.

**Treatment.**—The treatment of this disease implies the removal by surgical measures of all nodules and other growths that are forming about the maxilla or in the sub-cutaneous tissues of this locality, under strict antiseptic precautions, together with supportive diet, hygienic measures and constitutional remedies to suit the blood-poisoning state.

**MEDICATION.** The remedies that will be found especially beneficial are carbolic acid, arsenicum, lachesis, secale, mercurius, cinnabaris, silicia, and calcarea fluorica. When suppuration has set in silicia and hepar may be required, and for profound systemic invasion arsenicum, lachesis, carbolic acid, baptisia and rhus tox. may be needed. Fluoric acid, calcarea fluorica and the various preparations of mercurius will be needed as the maxilla or teeth are involved. Iodide of potash has been used in full doses in cattle, with claims of success, but it is not unlikely that the homeopathic preparations of iodine, especially arsenicum jodatatum and kali jodatatum will be found more useful.



## CHAPTER XV.

### CARBUNCLE.

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**Definition.**—A carbuncle is looked upon by most surgical authorities as an aggravated type of boil, the chief difference lying in the fact that furuncle has a single point of infection and discharge while carbuncle has several openings. Strictly speaking, carbuncle is a suppurative, even gangrenous, inflammation of the skin and sub-cutaneous cellular tissue. The inflammation spreads much more extensively and also more deeply than in the common boil and the constitutional symptoms are more profound, carbuncle even being dangerous to life.

Carbuncle is rarely seen in infancy or early life, being almost invariably a disease of advanced years unless in association with diabetes. It has for its favorite site the back of the neck or the integument and sub-cutaneous tissue lying immediately over the spinal column. The skin in the region originally attacked by carbuncle is thick and dense, the hair follicles are shallow, and are projected when it distends into the layers of the cutis vera. The only communication with the sub-cutaneous fat is by means of the oblique columns, the columnæ adiposæ, which are found beneath each hair follicle, and contain fat cells and vessels, and also loose connective tissue. The coil of the sweat gland is found suspended midway in the shaft. The adipose columns open below the cutis, opening upon fibrinous tissue which extends obliquely into the sub-cutaneous structures beneath the attaching fascia of the underlying muscles. These fibrinous bands interlace in various directions, forming a dense network and holding the skin firmly in place; in their interstices there is found connective tissue freely occupied by fat cells. It is this peculiar anatomical structure beneath the skin of the neck and the upper part of the dorsum that accounts for the characteristic inflammation and swelling of the carbuncle. The infection follows the hair follicle to its base and communicates via the columnæ adiposæ with the connective tissue underlying the skin, there spreading out in all directions, giving to the carbuncle a large base, whereas the boil or furuncle is much more conical in form, less flattened and less extensive in basal area.

It is clinically understood that carbuncle has a number of outlets instead of a single one, as with the furuncle. This is because pus that has formed beneath the cutis attempts to find an opening, following the columnæ adiposæ instead of entering the deep hair follicles of other localities. The very density of the skin and the fact that it is bound down to the underlying tissues by the fibrinous bands described prevents its rising in conical shape and tends to spread it out to still larger dimensions. Thus carbuncle will often have a diameter of three or four, or more, inches. If the tissues are not too firm there may be pronounced elevation of the skin and sub-cutaneous tissue until the carbuncle stands up from the surrounding healthy integument in size as large as a small, flat tea-biscuit. The disease does not penetrate the deep fascia, as a rule, yet

in unusually malignant cases the pus may burrow down into the deeper fascia and tendinous tissues, even penetrating the spinal canal or burrowing through the foramen magnum. In severest cases the coagulation-necrosis may be extensive and large gangrenous sloughs be the result. In one case observed by the author the spines of three dorsal vertebræ were exposed by a carbuncle slough that was nearly four inches in extent in its long axis by more than three inches in width, it taking weeks for its cavity to fill by granulation.

**Symptoms and Course.**—It would naturally be supposed that carbuncles are more painful than boils because they are larger and because of the inelasticity of the tissue covering carbuncular inflammation. In a manner this supposition is correct. Malignant carbuncle is exceedingly painful in its first stage, and its constitutional symptoms are profound. There is likely to be sharp rigors, severe rise in temperature, intense headache, delirium, anorexia, nausea, even to vomiting, and in some cases a large area of surrounding erysipelatous inflammation. In other cases the severest symptoms are those of local pain. The parts are distended until the pressure of the firm skin causes intense suffering, and the tissues involved in the process ache, throb and burn, preventing sleep, with nightly aggravations and general systemic shock. But as the process extends and pus forms an anesthetic state is often observed, coagulation-necrosis occurs, and the patient is rendered free from suffering, though his system shows severe shock and general debility; and constitutional infection may endanger life. As the gangrenous sore sloughs relief from pain is complete, though the surrounding healthy tissues are sensitive to touch and are usually somewhat swollen and infiltrated. If the pus burrows along the course of the fascia into the tendinous tissues and muscular structures beneath the constitutional symptoms become more emphatic, repeated rigors, sharp rises in temperature, colliquative diarrhea, and other symptoms of general pyemia are observed. If the meninges, either of the spine or brain, be attacked, severe headache, delirium and even convulsions may ensue.

The course of carbuncular inflammation may extend over a period of several weeks. Aged individuals and diabetic subjects are endangered in severe cases, and even in robust individuals the prognosis is grave if they be of intemperate habits or gourmands, and if the carbuncular inflammation be unusually malignant and near the brain. Carbuncles of the face may be vicious, even gangrenous, but are not as likely to endanger life as those occurring on the back of the neck. Carbuncles seen in diabetic subjects are more likely to become gangrenous than in healthy individuals.

**Treatment.**—In general the surgical treatment of carbuncle is that of furuncle. If seen early the central vesicle should be incised and the focus of infection be destroyed by the application of crude carbolic acid, nitrate of silver, or the application of a strong solution of bichloride of mercury. If diffuse inflammation in the connective tissue beneath the skin has already occurred its line of termination will be marked. Here a hypodermic injection of three per cent. solution of carbolic acid has been practiced, but the results have not been satisfactory and in some cases systemic disturbances have followed upon this practice. A late local treatment is the hypodermic injection of ethereal solution of iodoform.

The same objection obtains with this that obtains to the injection of carbolic acid or the compound tincture of iodine, none of which have been found satisfactory in results. If considerable infiltration has occurred when the case is first seen, the carbuncular inflammation having spread over a considerable area and the tissues having become boggy and semi-phlegmonous, the practice has long been to incise freely from center to circumference with numerous incisions, or to practice crucial incision of the inflamed mass. It has been the practice with some surgeons to make free sub-cutaneous incisions on the flat, thus loosening the dense cutis vera from its firm attachment to the tissues beneath. These practices are not now generally approved. The degree of operative interference that is necessary to success lends additional shock and increases the danger of sepsis. It also adds to the tediousness of recovery in the fact that the surgical state is added to the already diseased state. Instead of these practices it is now quite the rule to make a free incision directly across the carbuncular mass, through its center, subsequently loosening the derma from the connective tissue beneath, and curetting away all disintegrating tissue. If practiced without anesthesia this is a painful operation, likely to add to the shock the patient is already suffering. Nor is it possible to produce the degree of local anesthesia essential to its painless performance; hence, when this method is determined upon the patient should be anesthetized, the superficial parts rendered as aseptic as possible, and the operation and subsequent measures be practiced under rigid antisepsis. Curettage completed, the wound should be thoroughly cleansed with a bichloride wash or carbolic acid solution, and subsequently dressed with iodoform, sterilized or medicated gauze and the liberal application of an antiseptic dressing, which should be firmly strapped over the entire inflamed surface in such a manner as to secure compression from center to circumference.

Where radical surgical measures are not possible or permitted concentric layers of narrow adhesive straps should be applied from circumference to center, sufficient opening being left through which free drainage from incisions previously made is insured. Firm, even compression will be required, and as a temporizing expedient it may be best to apply a linseed or other poultice over the central portion of the mass, in order to facilitate sloughing. As sloughs form these should be carefully separated and dissected away, the object being to get rid of all infective tissue as quickly as possible. The correct treatment of carbuncle implies the removal of the necrosed and necrosing tissue, free drainage, supportive measures and such constitutional remedies as best serve to allay pain and inflammation, secure rest without drugging, and promote healthy, healing processes.

**MEDICATION.** Aconite may be needed in the first stage of carbuncular inflammation, covering the pain, heat, restlessness and increased temperature that attends upon this stage.

Belladonna will be required if the pain is of a throbbing pulsating character, the mass bluish in appearance and congested. This remedy is especially called for if the tendency is to delirium and other cerebral symptoms.

Rhus tox. will be found beneficial in the intense suffering and restlessness that are seen at night. It is especially demanded if the tendinous



tissues are involved in the process, and there are lameness and soreness in the muscular structures and ligaments adjacent to the site of infection. It is also beneficial in the typhoid state that is often seen in connection with malignant carbuncle.

Anthracinum is recommended in especially painful and malignant carbuncle, it being highly extolled in some quarters. This is the nosode made from the product of the anthrax sore.

Baptisia, like *rhys tox.*, will be found applicable in the low typhoid state that often supervenes, and is especially to be administered when its characteristic delirium is observed.

Tarentula is extolled in gangrenous carbuncle, malignant pustule and similar gangrenous inflammations that are extremely painful.

Arsenicum and *carbo vegetabilis* are remedies to be considered in the low typhoid state that follows upon systemic infection, the former remedy being especially called for when the sore is unhealthy and gangrenous, its discharges putrid and sanious.

Silicia, *hepar sulphur* and fluoric acid will be found beneficial when the disposition is to sluggishness of healing and extension of suppuration.

Carbolic acid, *lachesis* and *kali permanganum* will often meet profound constitutional infection from carbuncular sepsis. For the relief of pain *aconite*, *belladonna*, carbolic acid, *tarentula*, *rhys tox.*, and other remedies, as indicated, will be found better than opiates, which depress the system and retard retrograde metamorphosis.

The diet should be wholesome, nutritious and supportive. Stimulants are to be avoided.

## CHAPTER XVI.

### FURUNCLES.

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**Etiology.**—Boils, or furuncles, are local inflammatory abscesses that are caused by invasion of bacteria into the deeper portions of the skin. The route of infection may be through the sudoriparous gland ducts or by means of the follicles as far as the sebaceous gland. The latter route is, perhaps, the more common, the infection germinating in the sebaceous glands and spreading from this point through the layers of the skin and connective tissues beneath.

Boils are commonly seen in persons suffering constitutional debility, in individuals convalescing from severe diseases, especially typhoid fever, in the subjects of pronounced and sudden changes of habits of life, and are often apparently the result of excesses or irregularities in gastro-nomic habit. It has long been supposed that they are due to impurities of the blood which nature undertakes to eliminate through the skin in the spring season, but this is an error. There is a direct cause for every furuncle, just as for every other type of infective inflammation.

Athletes undergoing unusually severe training are very subject to boils from bruising of the skin, or from the radical change in diet they undergo while training for the contest; or, perhaps, from infection by means of their clothing or from other cause.

Epidemics of boils have been seen to occur where it is difficult to determine the origin of infection, such epidemics being due, doubtless, to a mycelium taken into the system by means of food. Fungi thus introduced rapidly find their way to the skin, lodging in the capillaries and setting up infective inflammation. Boils may also be due to embolism, infective particles lodging in the integument, there undergoing disintegration and exciting inflammation.

Predisposing causes may be said to be uncleanness, unusually severe manipulations of the skin, diabetes, the anemic state, radical changes in diet, excess of indulgence in rich foods, improper articles of diet, and unusually violent exercise that necessitates the perspiratory elimination of an increased proportion of chemical solids.

**Symptoms and Course.**—The first observable sign of a common boil is a minute papule at the opening of a hair follicle. The pain, which in severe cases becomes pronounced, is preceded by an itching sensation. This is followed by a tenderness of the boil, and as the inflammation spreads the pain increases, the area of tenderness being also increased. With the increase of inflammation the tissues at the site of the boil become swollen, hard, red, even deep blue in color. Pressure is painful, and even the slightest touch in sensitive subjects, is distressing. There is a full, swollen, tight feeling as the furuncle increases in size and destroys the integument, and because of the increased vascularity a throbbing, pulsating sensation is imparted. Examination shows small crusts on the surface of the swelling which, if removed, exude a minute quantity of

serum or pus. Within two or three days, or at most within a week, the central portion of the furuncle, commonly denominated the core, which is due to the active growth of bacteria in the connective tissues with resulting coagulation, suppurates, and upon being incised discharges freely in proportion to the area of inflammation. Even when the quantity secreted is small a probe can be passed from a quarter of an inch to half an inch, or deeper, into the connective tissues from the minute central opening that exists at the original site of infection.

Furuncles developing in the sudoriparous glands are more painful, deeper-seated, and slower in developing and in recovering. A favorite site is the palm of the hand or the cheek. In infants sudoriparous boils are observed upon the thighs and nates.

From a single small boil forming at the site of a hair follicle from bacterial infection, or occurring from an insignificant abrasion of the skin through which poison is introduced, may develop a course of furuncles in an individual patient that may extend over the course of three or four months or longer, scores, even hundreds of boils being the result of a single infection. The contagion in these cases has been disseminated throughout the system, the constitutional condition of the patient doubtless contributing a fruitful field for the development of successive crops of these pests.

Severe boils cause severe constitutional symptoms, as headache, sleeplessness, sharp rigors, considerable elevation in temperature, anorexia and general discomfort and distress. Susceptible subjects become really ill from the worst types of boils, and if successive crops appear in an individual whose system is below par a state of ill-health lasting over several weeks is observed. Thirst, restlessness, headache, even delirium, is seen in association with severe boils about the head and neck in young subjects. Boils upon the fingers or hands may produce general lymphangitis of the arm, with enlargement of the glands of the axilla. Likewise boils upon the lower extremities may cause inguinal adenitis, even to supuration.

**Site.**—Favorite locations for furuncles are the back of the neck, the trunk and the buttocks. In some subjects the external auditory meatus is a favorite site, while in other individuals the nose is the favorite location. The backs of the hands are also a common site of furuncles, especially in the laboring man. In children who are not kept clean they are more numerous seen over the nates and thighs. No portion of the human system is totally exempt from them. If occurring in the neighborhood of the lymphatics extensive lymphangitis accompanies, in which event the systemic symptoms are more profound.

**Treatment.**—The proper surgical treatment of furuncles as they are developing is to apply firm pressure by means of an adhesive plaster perforated by an opening in the center, corresponding to the point of infection or the central point of the boil, for the purpose of preventing extension of infection, securing immobility of the tissues and protecting the sore from contact with clothing and other irritations. More radical measures are the immediate application of dilute carbolic acid, even its hypodermic injection, at the site of the hair follicle or sudoriparous gland that is primarily the site of the inflammatory process. The application of collodion at the periphery of the furuncle acts, as does the



adhesive plaster, in producing compression and encouraging discharge from the central site. When once the core has been thrown off the application of collodion and cotton in such manner as to produce even compression is comforting.

The direct application of liquefied carbolic acid, or of equal parts of carbolic acid and vaseline, at the site of infection often serves to abort an individual furuncle and thus prevent general furunculosis.

**INCISION.** The earlier free incision is practiced the more prompt is the recovery. It is quite the rule in ordinary practice to postpone the opening of furuncle abscesses until all the inflamed tissue has softened and until fluctuation is pronounced. This is an error. Incision should be practiced the moment it is determined that infection has occurred. The central area should be incised in the line of the integument sufficiently deep to open up the whole of the infected gland or follicle, the wound being immediately thoroughly washed with sterilized water, carbolized water or bichloride solution, and, if necessary, the central cavity curetted with a small scoop, the wound being dressed antiseptically, and the dressings allowed to remain undisturbed until healing is complete. If desirable the patient may be anesthetized, since incision of an oncoming furuncle is painful. Local anesthesia by cocaine, chloride of ethyl, or the application of ice for a minute directly to the inflamed surface, even the application of crude carbolic acid, which is painful for but a minute, produces a sufficient degree of anesthesia to allow incision with a small bistoury.

In large boils it may be desirable to compress the periphery with successive layers of strips of adhesive plaster applied in different directions to accentuate pressure toward the central point.

**POULTICING.** Poulticing is obsolete among modern surgeons, but is so extensively practiced among the laity and general profession that its mention is proper. Where permission cannot be obtained to practice incision poultices may be demanded as a means of "drawing" the pus to the surface, and more rapidly softening the integument at the site at which it is desired to induce discharge of the contents of the boil. To be effective the poultice must be hot, moist, and oft repeated. By preference linseed-meal or slippery-elm bark should be used. Domestic poultices are made of bread and milk, bread and water, soap and sugar and other like preparations. Naturally these are untidy and oft-times infectious. To prevent rapid drying of a selected poultice it should be prepared with lanoline or vaseline, or other suited oleaginous substance, and should be prepared in bichloride solution or carbolized water to render it innocuous. The poultice is clearly a make-shift, and has no proper place in correct surgery.

**MEDICATION.** The pain and inflammation of furuncles may be greatly relieved by the exhibition, in the initial stage, of aconite, ferrum phosphoricum, belladonna, cantharis, apis and sulphur. As suppuration is certain hepar sulphur (the calcium sulphide of to-day), silicia, calcarea, sulphur and other like remedies will be found serviceable. For severe systemic invasion, where furunculosis or successive crops of boils occur in debilitated subjects, arsenicum, lachesis, kali phosphoricum, carbo vegetabilis, tarentula, carbolic acid and other remedies of their type will be demanded.

Aconite will be needed when the inflammation is acute and the patient suffers from repeated sharp rigors, fever, headache, thirst and restlessness.

Belladonna is especially indicated in boils about the head and neck. The surface is congested, bluish, even purplish in color. The headache is intense and delirium accompanies.

Ferrum phosphoricum is useful for the general inflammatory boil with a considerable area of inflammation, without the intensity of pain and the hyperesthesia of aconite.

Mercurius serves to hasten suppuration where this is unavoidable, and thus promotes earlier termination.

Silicia retards suppuration and assists in recovery in cases in which the discharge is protracted from extension of invasion into surrounding tissues.

Apis is especially beneficial in intensely painful boils, the pain being of a burning, stinging character and the surrounding tissues considerably infiltrated and swollen, even edematous.

Hepar promotes suppuration and is especially beneficial in unhealthy boils with central sloughs and a tendency toward sluggishness of recovery.

Arsenicum and lachesis will be found serviceable in boils tending to phlegmonous complication. The lachesis boil is especially blue and its discharge offensive. Arsenicum is more likely to be required when the general debility of the patient is pronounced, his condition anemic.

Sulphur, psorinum and tuberculinum will be demanded in boils in tubercular subjects, and where the system has undergone repeated infection.

Graphites and pulsatilla will be found especially useful for boils about the eyelids. (Hordeolum.) Staphysagria will also be found beneficial in successive crops of styes.

Calcarea most often meets the boils of infants, and calcarea phosphorica will be found useful in boils occurring in teething children whose bones are slow in developing.

Diabetic boils will demand general diabetic treatment, and furuncles occurring in connection with constitutional syphilis will, naturally, demand anti-syphilitic medication.

## CHAPTER XVII.

### LUPUS VULGARIS.

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**Nature.**—Lupus is a tuberculous affection of the skin that is chronic and destructive in character. It is commonly seen in childhood, although it belongs also to younger manhood years. Koch has demonstrated that the bacilli of tuberculosis are to be found in the nodular enlargements belonging to the lupus sore. His experiments with tuberculin were made upon tuberculous skin and joints, rather than general tuberculosis, and it is not doubted that success attended the use of this nosode in numerous cases of skin tuberculosis.

Subjects of lupus are not necessarily victims of general constitutional tuberculous disease. They may be apparently in good health while suffering from stubborn exhibitions of lupus. Usually, however, where the individual subject is apparently in perfect health there is a base of phthisis in his antecedent history.

**Varieties.**—Lupus is seen in two forms:—Lupus non-exedens or simple lupus, and lupus exedens or ulcerated lupus.

**LUPUS NON-EXEDENS.** This variety appears as a red patch on the skin. It is more commonly seen on the face, but it is always observed on other portions of the system, especially the thighs, usually the anterior surface. Commencing as a small red spot it extends much like ring-worm, spreading in irregular outline, the outer edges being red, somewhat inflamed and tender and characterized by nodulations in the margins of the lupus sore. These nodules are indolent tubercles. They occasionally become irritated and break down, though more often they dry and scurf with bran-like desquamation. As the disease spreads over the original foci the central portions of the affected area become pale, even pearly white, while the edges are red and raised.

The nodules consist of small-celled infiltrations of the corium, with a few giant-cells scattered throughout the masses. If they break down disintegration occurs in the center, giving to the nodule the appearance of a pustule, which is filled with an "apple jelly" substance. In more unhealthy subjects crusts form wherever the nodules disintegrate, the general appearance being that of an eczematous sore. If the destruction of the nodules be considerable a pinkish scar forms at their site, it being often observed that new nodules are forming, mature nodules are breaking down, and those undergoing disintegration are cicatrizing at the same time in the same sore. This type is further described under Lupus Erythematosus.

**LUPUS EXEDENS.** The ulcerative variety of lupus is more commonly seen on the face, especially the tip or wing of the nose, sometimes on the upper lip. It is more commonly observed in subjects whose family history is notably bad, whose general health is below par, and whose sanitary surroundings are not of the best. This variety begins much as does simple lupus, reddish papules or tubercles showing as the first symptom instead of the scurfing with dry, bran-like scales of the



simple variety. These lupus nodules break down and ulcerate. The ulceration may be deep and malignant in the phagedenic variety or it may be superficial. In the latter case the nodules are more likely to be fungus and warty, the surface of the sore being irritated and tender, but ulcerating only at the site of the largest tubercles. In the phagedenic ulcer the whole area breaks down and sloughs. This type is exceedingly painful, considerable areas of tissue are destroyed and the

discharges are fetid and excoriating. If the nose be the site of the diseased portion it may be altogether destroyed. If it is the lip that is affected this may be entirely eaten away. In severest cases the face may be one great mass of lupus ulcer, the patient being hideously repulsive and suffering intensely. (Fig. 19).

Not only are the superficial tissues destroyed by the phagedenic form of ulceration but the gums, palate, pharynx and even the larynx may be attacked. The bones of the nose may be destroyed, the antrums invaded and even the lids and conjunctivæ may be eaten away.

Lupus rarely attacks the mucous membranes primarily. Its preference is for the skin, its native habitat the corium. But when appearing upon the face or about the thighs or genitals it may invade

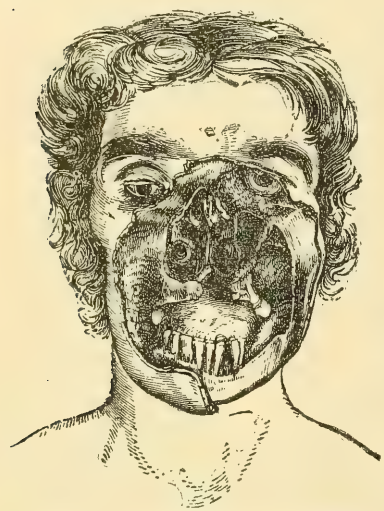


Fig. 19. *Lupus Exedens*.—(Adams).

the mucous membranes adjacent thereto. The lymphatic glands subsequently become involved, and especially in strumous subjects will extensive glandular abscesses be observed in association with the more malignant types.

**Duration.**—Lupus is essentially a chronic disease. It drags along in all cases from months to years, resisting treatment, relapsing when presumably cured, and re-occurring in individual cases even years after its removal and supposed eradication. It is rarely fatal, leaves large cicatrizes, especially on the face, and by causing contractions produces distortions of the features and ugly deformities. If epithelioma sets up in an old lupus patch, as is very likely to be the case, it becomes rapidly destructive and leads to a fatal issue. The presence of a destructive ulcerative process at the site of an old lupus is often confusing. The condition may be that of recurring lupus; but the development of epithelioma upon the site of the former lupus must always be borne in mind as a reasonable possibility, especially in enfeebled subjects of middle life.

**Microscopic Appearances.**—The corium is found to be infiltrated with round cells, usually arranged along the track of vessels and forming in clusters about them. Spindle-shaped cells and giant cells are also observed in the lupus tubercles, but are not plentiful. The cell infiltration originates in the exuded white corpuscles and the appearance of giant cells is supposed to represent an intermediate stage in the process of lupus degeneration.

Friedlander and other observers look upon the nodosities of lupus

as true tubercles. Koch so considers them. On the other hand Colomitti viewed them as phagedenic destructive processes, lacking the essential characteristics of pure tubercles. The giant cells are more commonly seen in the ulcerative variety, while in the superficial form the characteristic condition is simply that of infiltration of round cells with individual giant cells occasionally seen in the nodular edges of the diseased area.

**Diagnosis.**—It is necessary to differentiate lupus from epithelioma when it occurs about the angle of the mouth and wings of the nose, especially at the site of the old lupus sore. It is also necessary to differentiate it from syphilis, more particularly when seen about the genitalia. In the latter the disease-patches are more crescentic in outline and are separated by considerable areas of healthy skin, whereas in lupus the patches coalesce, forming a more continuous sore.

Syphilitic lupus usually appears upon subjects possessed of other symptoms, as notched teeth, rhagades, mucous patches, nervous manifestations and ositic nodes. If syphilis be the disease the tubercles are of a deeper color, even brownish, and are more dense and resistant than lupus. In dry lupus the center of the nodule is occupied by a jelly-like substance called the "apple-jelly" secretion of this disease. This is never present in syphilis.

Another distinctive point of value in the diagnosis is the age of the patient. Lupus is a disease of young life. Syphilis is almost invariably seen in the early years of manhood, though not uncommonly observed later. If doubt arises as to whether the disease be syphilis or lupus in very young subjects the more chronic course of lupus and the more acutely destructive course of syphilis should be borne in mind. Inherited syphilis is accompanied by necrosis of the bones in the immediate vicinity of the syphilitic sore, while in lupus bony destruction occurs only in the most malignant variety, the *noli-me-tangere* of old authors.

If there be a combination of syphilis and tuberculosis in a child the diagnosis is even more difficult. If keratitis appears in connection with the presence of a supposed lupus-destruction it points more clearly to syphilis. The more rapidly destructive nature of inherited syphilitic lupus will render early diagnosis certain. This type of disease will destroy as much tissue in a week or two as ordinary lupus will destroy in months or years. (Moullin.)

A further means of diagnosis between syphilitic lupus and the tubercular form of the disease is found in the use of mercury and potash. These anti-syphilitics are capable of inciting quick improvement in even very malignant types of syphilitic lupus, whereas in the tubercular form of the disease they are of no value whatsoever.

The diagnosis between epithelioma and phagedenic lupus is less difficult, as will be seen by reference to the chapter on epithelioma in the section on Tumors. If epithelioma-destruction sets in in a subject of middle life at the site of an old lupus sore the diagnosis is not always easy, in fact is sometimes very confusing. The more rapidly destructive character of epithelioma and its microscopic appearance will determine the diagnosis.

**Treatment.**—The treatment of lupus is resolved into the application of constitutional measures that support the system and improve the

general health and in local treatment, the latter consisting of thorough removal of the mass by scraping, by cauterizing or by the action of certain chemical agencies that destroy the lupus growth; while the general measures that should be employed are liberal supportive diet, outdoor exercise, change of climate from the interior to the sea-shore or from the low-lands to the mountains, the exhibition of cod liver oil, petroleum emulsion and other supportive agencies—the object being to improve the general health of the patient—and the further exhibition of constitutional aids, as sulphur, psorinum, silicia, arsenicum jodatum, sepia, tuberculinum, calcarea sulphurica, natrum sulphuricum and other well-selected constitutional remedies.

**SURGICAL TREATMENT.** The most commonly performed surgical measure for the treatment of the disease is thorough scraping of the diseased area by Volkmann's sharp spoon, Fig. 20.



Fig. 20. Volkmann's Sharp Spoon.

The patient is anesthetized, the surgical area treated to a thorough course of antiseptics, and all diseased tissue scraped away. Care must be exercised at the edges of the lupus; especially that all be removed. If there be a vestige of the disease remaining eventual renewal and spread will occur. When thorough scraping of the diseased mass has been effected crude carbolic acid may be applied with caution, especially at the former site of tuberculous nodules; or the excavations which are left in their removal may be touched with the actual cautery. The subsequent dressing should be applied with reference to the avoidance of sepsis and the induction of healing with as little cicatrization as possible. Boracic acid ointment, calendulated vaseline, iodoformed unction, borated lanoline or other medicament may be used as freely as necessary. If preferred the wound may be dressed dry, its immediate covering being iodoformed—or borated—gauze, this being plentifully covered with antiseptic wool or cotton bound firmly to the part. Dressings of this character are not practicable if the face be the field of operation.

Other methods of surgical treatment that have been employed are the direct application of the actual cautery, linear scarification, or hypodermic injection of carbolic acid, five to ten per cent. strength, the application of chromic acid by means of a glass rod, chloride of zinc and potassa fusa, and other escharotics, all of which have been employed with varying degrees of success.

The more accurate and scientific surgical treatment of the lupus sore is removal by means of the Volkmann spoon or the knife and scissors. The escharotic treatment by destroying pastes is not now in favor. Koch's tuberculin has been used with some success but is not generally employed.

**MEDICATION.** The constitutional treatment of the lupus patient is demanded if the best results would be obtained. In strumous children of lax fibre, lymphatic temperament and non-resisting habits, calcarea carbonica will be found a remedy of value.

If the glandular system be involved in the process calcarea jodata will be a more useful remedy, rivaling arsenicum jodatum as applied in adults.



If considerable area of the superficial skin be affected natrum sulphuricum and calcarea sulphurica, as indicated, will be found helpful.

Kali muriaticum will meet those cases in which the nodulations are gummy and sticky, and in which a healthy crust with moisture beneath forms at the margin of the sore.

Thuja should not be overlooked when the lupus is engrafted upon the syphilitic base. The skin is dry and unhealthy and the nodules become fungous in character. Condylomata form about the genitalia when this locality is the site of lupus non-exedens.

Nitric acid will be found more useful in lupus affecting the face that is destructive in character, especially when the nasal bones and palate are involved.

Mercurius will also be found a valuable remedy when syphilis is at the bottom of the trouble, as also when the gums and alveoli are affected by the destructive process.

Psorinum, tuberculinum and sulphur will be found valuable as basic remedies, according to the constitutional state of the child.

## CHAPTER XVIII.

### LUPUS ERYTHEMATOSUS.

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**Nature.**—The erythematous variety of lupus is very like the vulgaris in its microscopic peculiarities and pathology, but while there is an abnormal vascularity in this type the tendency to destruction of tissues is very much less. It is not so uniformly seen in early life, but in other respects its course is very much like that of the variety already described. Its preference is for the nose, cheeks, ears, back of the hands and other exposed tissues. The erythematous variety is peculiarly symmetrical, not running in irregular shapes as does the vulgaris. If the face be the site of the disease it is apt to appear upon the cheeks in bat-wing shape, showing a reddish or brownish color, the diseased tissue being raised above the surrounding healthy surface, and dilated capillaries and small veins being observable throughout the affected area. There may be dry, eczematous scalings over a portion of the diseased patch, and if the edges of the affected area are much thickened and raised this may scurf, leaving the surface beneath the scalings bright red in color, with itching and tingling of the reddened skin.

Lupus erythematosus is more commonly seen in men given to the drink-habit and those who are accustomed to indulgence in rich foods and high wines. It is not uncommonly associated with acne and is seen to follow upon attacks of erysipelas. This type of lupus is also observed in anemic subjects whose blood is vitiated and whose habits of life are not hygienic.

**Treatment.**—The treatment of this form of lupus is non-surgical. The application of astringent ointments, collodion, contracting washes, and the administration of constitutional remedies as ferrum phosphoricum, secale, cantharis, thuja, belladonna, rhus tox. and sulphur, as indicated, constitute the most satisfactory methods of treatment. The application of crude or diluted carbolic acid, escharotic pastes and sharply astringent and stimulating applications are harmful. Lupus erythematosus is an inflammation of the corium and epidermis and should be treated as such. If tuberculous nodules form at any point in the diseased area these should be scraped or treated by the fine-pointed cautery. If the vascularity of the tissue is pronounced it may be well to employ the scarification method recommended in the treatment of nevi.





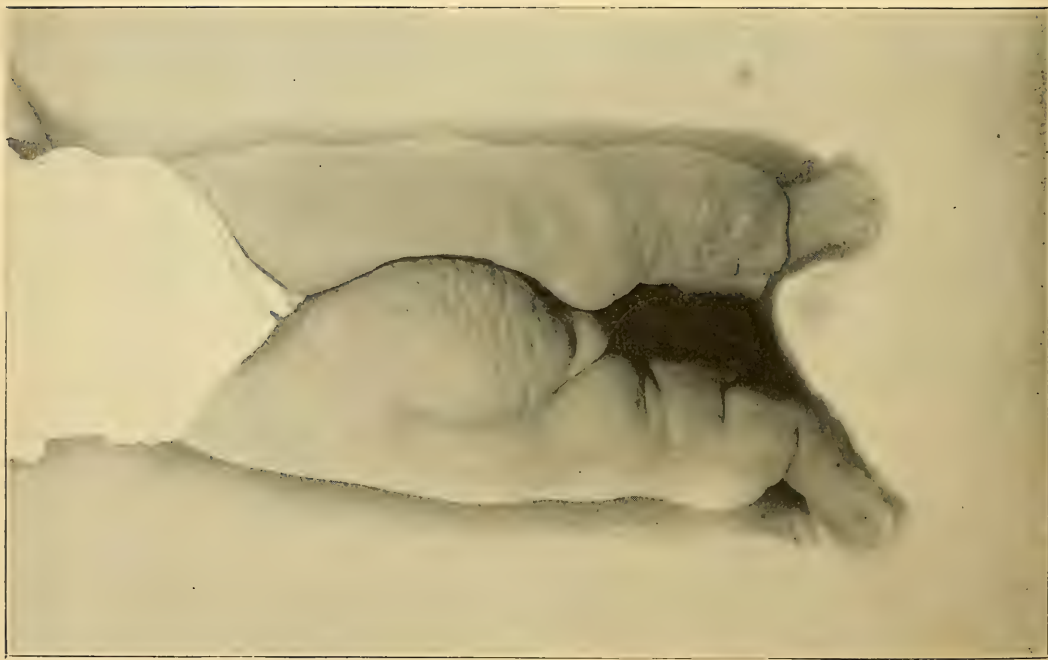


Figure 1. Front View.

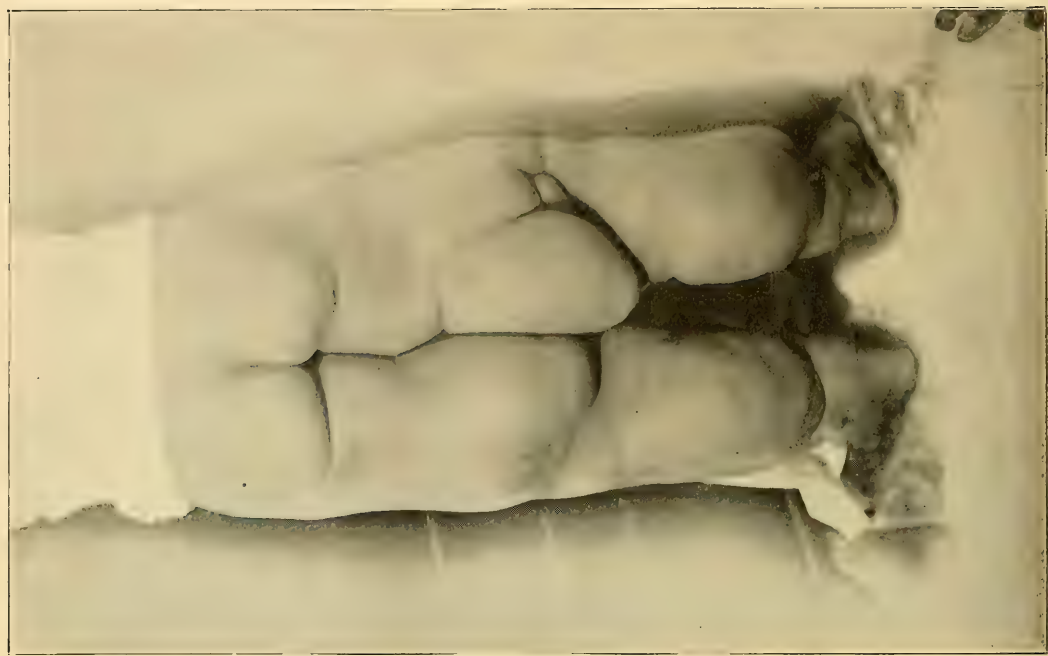


Figure 2. Rear View.

PLATE V, A.—ELEPHANTIASIS ARABUM.—CASE OF E. E. PINTLER, M. D., NEW BREMEN, OHIO.

## CHAPTER XIX.

### ELEPHANTIASIS ARABUM.

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**Nature.**—Elephantiasis is an hypertrophy of the skin and areolar tissue beneath. It most often affects the integument and areolar tissues of the lower limbs and scrotum. It is very common in Barbadoes and is seen throughout Arabia, especially. It is thought to be due to obstruction of the lymphatic vessels and cellular tissues. When seen in the scrotum the skin and subcutaneous tissues alone are affected, the cellular elements and fibrous tissues being enormously increased. The surface is at first smooth and rounded, but as local inflammation sets up it becomes irregular with nodulated obstructions and rupture of lymphatics occurring, the interstices filling with lymph and in rare cases being occupied by a mixture of lymph and chyle. Elephantiasis Græcorum, or true leprosy, is accounted a constitutional disease, appearing as a tuberculous affection of the skin, whereas elephantiasis Arabum or Barbadoes leg is a separate ailment, affecting usually one of the lower extremities or appearing in the male or female genital organs. It shows as a general infiltration into the skin and subcutaneous tissue of an organizable material, whereby the integument becomes hypertrophied and greatly thickened. (Bryant.)

**Symptoms and Course.**—This type of elephantiasis usually begins with an attack of fever, the affected part soon becoming red and swollen and covered with a general erythema. As this subsides it will be observed that slight thickening of the integument is left behind. The attack is soon repeated and continues to recur with varying degrees of intensity, extending over a long period of time, until finally the skin is enormously thickened, brawny and tense, hanging in great folds with fissures between them from which is exuded an offensive sticky secretion. In severe cases these fissures are the site of ulcerations, giving a great deal of annoyance and rendering the parts affected exceedingly unwholesome.

It has been held by various observers that elephantiasis is primarily an inflammatory disease of the venous system, while others contend that it is associated with enlargement of the arterial trunks of the part. By still others it is held to be a form of leprosy and since it occurs most commonly in Southern countries it has been suggested that it is due to malarial infection.

As the disease progresses the part affected becomes enormously distended, rendering the patient more or less helpless, depending upon its extent. (Fig. 21.) Fortunately elephantiasis is rarely observed in this country.

**Treatment.**—If the scrotum be the site of the disease and if it be enlarged to that extent that locomotion is rendered impossible and the patient is otherwise severely uncomfortable amputation should be practiced. Picton, New Orleans, successfully removed a tumor of this

nature in 1837 that weighed fifty-three pounds. Boseman of New York removed one weighing forty pounds, and Thebaud, also of New York, removed a third in 1866 which weighed sixty-three and one-half pounds.



Fig. 21. Elephantiasis of Leg.

Of one hundred and thirteen cases operated upon at the Medical College Hospital, Calcutta, but twenty-one died; the causes of death being pyemia, diarrhea and exhaustion, shock, tetanus and gangrene. Clot-Bey reports four cases operated upon in Egypt in which the tumors weighed respectively sixty-five pounds, eighty pounds, seventy pounds and one hundred and ten pounds. It has been observed that extirpation is a safer operation after the tumor has attained its maximum growth than while it is developing when more or less inflammatory action is present.

If the leg be the site of the disease amputation is not advisable, the treatment here being limited to ligation of the large blood vessels supplying the hypertrophied part, and, if necessary, excision of a portion of the nerve trunk adjoining the ligated artery.

On the whole it may be said that surgical treatment of elephantiasis of the leg is futile, while that of elephantiasis of the scrotum is comparatively safe and reasonably successful.

**OPERATION.** The patient being anesthetized and the operable tissues being rendered as surgical as possible, a sound is passed into the canal of the scrotum surrounding the penis and a lateral, crescentic incision corresponding to the necessities of the case is made. Two vertical incisions are then made, one on each side, uniting with the extremities of the crescentic flap,

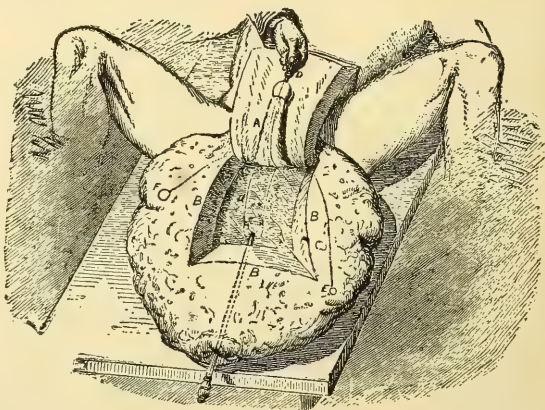


Fig. 22. Elephantiasis of Scrotum.—Thebaud; A, Penis with sound introduced; B B B, Lines of incision for Central Flap; D, Central Flap turned back; E, position of Left Testicle; F, Right Testicle; D, the dotted line indicates the position of the Penis before it was dissected from its bed. The sound is also shown passed up through the canal to the head of the Penis. (Hamilton.)

and made to uncover the penis. (Fig. 22.) This flap is now reflected up and the sound introduced into the bladder. The testes are searched for and brought into position if found to be in a healthy state. The hypertrophied scrotal tissue is then carefully dissected away, all of the hypertrophied flap that is not needed in the finished operation is then dissected off and the lateral edges of the original vertical flap are brought together and united by sutures deftly and accurately. All



bleeding vessels must be closed by ligature or torsion as may be necessary. Thorough antiseptic measures must be practiced throughout the operation and the wound dressed antiseptically until perfect healing has been secured.

## CHAPTER XX.

### ABSCESSSES.

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**Varieties.**—Abscesses are the result of circumscribed inflammation and are divided into acute and chronic, depending upon their nature, intensity of symptoms and promptness of recovery. An abscess may also be due to the softening and liquefaction of masses of caseous material from the presence of specific germs operating over a long period of time, this type being different from acute abscess in the fact that it is not attended by the acuteness of inflammatory symptoms and that it does not contain true pus.

The typical acute abscess at maturity is occupied by a thick, creamy, yellowish-white or greenish-yellow pus of alkaline reaction. If the secretion be mixed with blood the term sanious is applicable. If it be thin, watery and excoriating it is called ichorous. If the pus be organized in lumps or flakes it is denominated curdy. The secretion may be infective if charged with micro-organisms and it may be so specific in nature as to be able to reproduce the special disease in which it is seen in association, as septicemic abscesses, scarlatinal abscesses, tubercular abscesses and other varieties.

Other classifications that are given to abscess formations are the phlegmonous, when the deeper tissues are involved and extensive suppuration follows; the cold or lymphatic abscess, generally accounted tuberculous in character and usually involving granular structures; the metastatic or pyemic abscess, resultant upon the presence of pyemia and the lodgment of infarcts in different portions of the system, with abscess formation as a result. There is also the emphysematous abscess, in which there is a mixture of air, the diffuse or spreading abscess, and the burrowing abscess that follows the course of tendons or of the tissues, the pus finding exit at a point far removed from the original site of the inflammatory process.

**Abscess Pus.**—The pus of a typical abscess consists of pus corpuscles mixed with germs floating in a fluid that is highly albuminous in character. The pus corpuscles may be identical with leucocytes and capable of ameboid movement. They are round, slightly irregular in shape, granular, and about one one hundred and twenty-fifth of an inch in diameter. The nucleus of each corpuscle is bifid or trifid. The pus granules consist chiefly of fat, and in old collections the corpuscles are completely disintegrated, nothing being left but thick, caseous material mixed with crystals of cholesterin. The germs that are found in abscesses will depend somewhat upon the nature of the process. As a rule they are the streptococci or staphylococci. Various organic salts are present and the color that is imparted to the pus is due to the presence of altered hemoglobin.

The consistency and nature of pus from an abscess will depend somewhat upon the character of tissue involved and the nature of the

abscess. If it be of the acute inflammatory type, with a quick formation of pus, shreds and sloughs of destroyed tissue will be found in the pus—due to necrosis from the acute inflammatory action. These are usually made up of the denser tissue of the diseased part, being composed of shreds of fasciæ and tendons. Softer tissues are more completely disintegrated by the peptonizing of the cocci. The emphysema which is sometimes observed in abscesses is due to putrefaction and the evolution of gases that go on during the destruction of the local tissues, or to the admission of air by whatever means possible.

**Acute Abscess.**—Acute abscess is characterized by the presence of inflammation, swelling, pain and destruction of tissue. It may be due to traumatism, but is more commonly the result of infection. There will appear at the local site of inflammation a small area of redness, the tissues become tender, swelling is observed, the skin grows tense and painful to touch, and as it is distended by increased swelling it becomes shiny, even glazed in appearance, gradually assuming a darker hue, even to a deep red or purple. The swollen mass is hard and tense in some cases, brawny and edematous from infiltration of lymph and infusion of serum. If the process pursue an undisturbed course in from forty-eight to seventy-two hours from the initial symptoms there will be signs of softening about the center of the sore and palpation will show fluctuation, indicating that the inflamed tissues are breaking down and that the mass is being transformed into liquid.

Over the thinnest portion there will be protrusion, softening of the skin at this point, even desquamation of the cuticle. As the pus-formation progresses at the site of the threatened “pointing” the color will change to a lighter hue, eventually showing as a white or yellowish central spot. In simple acute abscess the entire process may be completed in seventy-two hours; in other cases it may be a number of days before the pus will have formed and the entire mass will have softened. If not yet incised a small circular slough will form at the thinnest part of the abscess, the connective tissue and skin becoming necrosed at this point, at which site the pus escapes. This necrosis is due in part to the distension and pressure of the confined secretion, in part to strangulation of the capillary circulation by virtue of the swelling at the periphery of the abscess, and perhaps in part to the peptonizing influence of the cocci within.

If an abscess points and breaks externally the best results that nature is capable of will have been obtained. If it be in a deeper organ rupture may occur into an adjacent canal by the abscess pointing to the surface, as in abscess of the liver, abscess of the lung, abscess of the intestines and other internal abscess-formations. If on the other hand the pus fails to find its way to the surface but burrows into deeper structures, profounder systemic symptoms are set up, with complications that may prove disastrous.

Besides the local symptoms of deep inflammation—as redness, pain, tension and throbbings—constitutional symptoms attend upon all acute abscess formations. There are headache, thirst, fever, repeated chilly sensations, or perhaps a single sharply defined chill at the time of the infection or at the time the formation of pus begins. Recurring chills are apt to indicate extension and recurring abscesses. If an abscess



be located near lymphatic glands these may be sympathetically involved, becoming painfully enlarged, even indurated.

**DIAGNOSIS.** There is usually not much difficulty in diagnosing an acute or phlegmonous abscess. The history of the case, the constitutional and local symptoms of inflammation, pain, chilliness, fever, the disposition on the part of the abscess to point or soften at a particular spot, and the presence of fluctuation are generally sufficient to clearly determine the nature of the condition.

**FLUCTUATION.** Fluctuation is practiced by placing the fingers longitudinally in relation to the muscular fibres of the part, one on either side, by preference the fingers of the two hands, and by alternately pressing from the opposite sides a wave-like motion of the fluid within will be communicated. In pronounced cases it is sufficient to apply quick, gentle pressure with a finger directly over the most prominent part of the abscess, this revealing the presence of fluid within. When there is considerable quantity of pus there can be no difficulty in determining its presence. When, however, but a small central portion is softened, the surrounding tissues remaining hard and firm, the detection of pus is not always easy and it may be necessary to incise the inflamed mass or to aspirate its center with the aspirator or hypodermic needle. In all doubtful cases the latter method should be employed, since it is ever advisable to freely incise the abscess mass the moment pus is detected.



Fig. 23.

Straight Bis-  
toury.

Confusion may arise in the case of hematoma, lymphoid tumors, lipoma, aneurism and in certain cystic formations; but confusion and doubt are easily cleared away when the history of the case is considered. The throbbing pain, the acute discoloration, the quick swelling, the firmness and density of the inflamed area, the headache, fever and other constitutional symptoms described are not seen in association with any of the conditions with which a simple abscess might be confounded.

**TREATMENT.** Acute inflammatory abscess, whether appearing in the form of whitlow, phlegmonous inflammation of the cellular tissue, simple furuncle, or acute periostitis, should be freely incised the moment pus is detected, and even before this. Dilly-dallying measures are never justifiable. The "scattering" of an abscess is legendary; free incision is the best possible prophylaxis, in fact the only method of treatment that is strictly surgical and scientific. In incising into an abscess care should be exercised not to sever good-sized blood vessels, nerves, tendons or individual muscles. Natural folds of the skin should be selected as the site of incision when possible, in order to avoid unnecessary scarring; but it is more important to pay attention to the course and relation of more important structures. Incision should be made parallel to blood vessels, nerves, ducts and bands of muscular fibre. The old-fashioned method of lancing with abscess-lancet is not justifiable. Free incision with the bowl of a scalpel or abscess knife, with the object of securing as long an opening at the base of the wound as at its surface, the object being to secure free emptying and thorough drainage

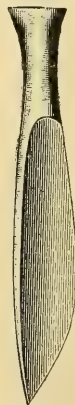


Fig. 24.  
Scalpel.

of the cavity, is the measure demanded. The knife should be introduced perpendicularly unless it be possible to press the abscess well up between the fingers, when the handle of the scalpel may be held in a line almost parallel with the surface of the affected member. In this instance the point of the scalpel is inserted, first being carried clear across the abscess track, the bowl of the blade freely incising the integument and tissue immediately beneath as the point is pushed on through the abscess, to make its exit opposite the point of entrance. If for any reason it be not wise to incise as freely at the base of the wound as at its surface dressing forceps should be introduced in the incision, closed and opened at the base, being allowed to remain open as withdrawn, the thought being to enlarge the opening at the site of the pus to correspond with the superficial incision.

In some cases it may be found desirable to make a small incision with a sharp-pointed bistoury (Fig. 23), subsequently inserting a grooved director and further incising slowly and measuredly, with the scalpel guided along its groove. This method will be found suited to deep abscesses where it is necessary that care shall be exercised in order that important structures be avoided. It may even be desirable to empty a considerable-sized abscess by a small opening made with the bistoury and grooved director, the walls of the abscess being subsequently torn by the insertion of the dressing forceps, their blades distended and withdrawn while separated, in which event it will be necessary to introduce a drainage tube, securing the further emptying and cleansing of the cavity.

**COUNTER-OPENING.** In the case of large phlegmonous abscesses it is often desirable to make a counter-opening opposite the point of primary incision, or opposite the most dependent portion of the cavity. When this measure is practiced it will generally be necessary to follow with the insertion of a perforated drainage tube through which the cavity may be rapidly cleansed. It rarely happens that more than one counter-opening is required, yet in special cases two or more may be needed, depending upon the nature and extent of the abscess, the character of the tissues that are affected

and the necessity for the securement of permanent drainage, that serious complications may be avoided.

As a rule the soft-rubber drainage tube shown in Fig. 26 is preferable. In rare cases the perforated glass tube may answer a better purpose. In simpler abscesses drainage by capillary attraction by means of sterilized or iodoformed-gauze will be found adequate.

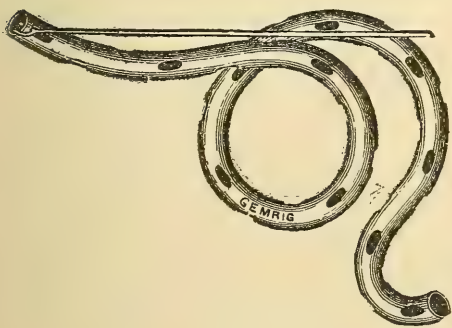


Fig. 26. Drainage Tube.

**MEDICATION.** The pain and inflammation attendant upon acute abscess-formation may be modified by the prompt exhibition of aconite, ferrum phosphoricum, belladonna or other suited remedy. If there be

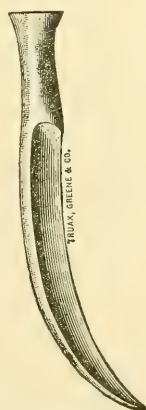


Fig. 25.  
Sharp-Pointed  
Bistoury.

repeated rigors with headache, restlessness, thirst, full, bounding pulse, intense throbbings at the site of the abscess, with hyperesthesia of the inflamed tissues, aconite will serve an excellent purpose.

Ferrum phosphoricum is better adapted to milder cases with more extensive involvements of tissue, but less acute constitutional manifestations. Instead of the temperature mounting to 105 or 106 degrees, as with aconite, the fever is less, rarely registering more than 102 or 103 degrees. The parts are not so tense nor is the patient so hyperesthetic.

Belladonna will be found beneficial in phlegmonous abscesses with congestive symptoms, severe headache, blueness of affected area, coldness of the extremities, delirium and other symptoms common to this remedy.

Gelsemium and veratrum viride may be required in individual cases for prolonged fever, severe cerebral symptoms and the systemic pictures belonging to these drugs. As suppuration becomes inevitable hepatic sulphur will be found helpful. Mercurius is another remedy for this state that will be serviceable. Silicia is better adapted to cases in which suppuration is usually prolonged. If gangrenous conditions appear to threaten arsenicum, lachesis, carbo vegetabilis, crotonus or secale may be needed.

**ACCESSORIES.** In superficial abscesses when the degree of inflammation is great the application of cloths wrung from very hot water will sometimes be found very grateful. Cold applications are also extolled in this connection, but heat is preferable. The poultice is accounted unsurgical and should be discarded. When the presence of pus is determined this should be removed. The knife, under an anesthetic, either local or general, as necessary, affords a far more accurate and certain means of exit than the unsurgical method of sloughing out an opening by means of poultices. These should only be employed for the purpose of assisting in securing the destruction of inflamed tissues that have been freely incised when subsequent curettage is not deemed advisable. The latter procedure should follow incision in every case where it is practicable, the sine qua non to prompt healing being complete removal of all necrosed and necrosing tissue.

**Cold Abscesses.**—Caseous, tubercular, scrofulous, chronic and syphilitic abscesses are but other names, or but classifications, at least, of the cold abscess of the old authors. These caseous abscesses are more common in connection with the tubercular diathesis. They are usually observed in the lymphatic glands of the neck, axilla or groin, are due to traumatism, with resultant self-infection, or depend upon infection by some slight scratch or bruise that has not attracted attention. This type of abscess is also observed in connection with tubercular disease of the bones. They are filled with a cheesy material that resembles pus but that contains few if any true pus corpuscles, being largely made up of disintegrating fatty refuse mixed with albuminous fluid. There is but little pain attending the cold abscess, nor are the constitutional symptoms generally pronounced. If acute infection at the site of a cold abscess supervenes there will then be acute constitutional manifestations very like those belonging to acute abscesses.

Cold abscesses may drag along for weeks or months without giving the patient material inconvenience. They sometimes attain large size, and as suppuration ensues the surface becomes thin, reddened and softened, giving way at the site of pressure from within and emptying a consider-



able mass of cheesy debris that is apt to be offensive. If occurring in children manifesting symptoms of tuberculosis more or less hectic is observed. Cold abscesses are apt to be chronic in nature, and while they may be confined to a single cavity yet it not infrequently happens that the pus burrows in various directions so that the sac has numerous offshoots. In typical cold abscess the fluid contents may rarely be absorbed, the cheesy or curdy material being inspissated, even undergoing calcification.

**TREATMENT.** The treatment of cold abscesses does not differ materially from that of the acute variety, except that every portion of the disintegrated mass should be scraped away with Volkmann's spoon or sharp curette. The acute abscess will usually take care of itself if free incision be practiced. Not so with the cold abscess. It may continue to discharge a thin, watery fluid, with considerable flakes of fatty debris mixed therein, over months or years, a sinus connecting the abscess cavity with the surface of the body without collapse. Healing occurs in acute abscess as the destroying inflammation subsides and its contents are emptied, while in cold abscess it is sometimes desirable, after thorough curettage, to pack the cavity with sterilized, iodoformed, or bichlorided gauze in order to stimulate granulation and filling-in of the cavity. Verneuil injects an ethereal solution of iodoform. Billroth prefers iodoform and glycerine. Bruns uses sterilized olive oil with iodoform instead of glycerine. Other surgeons recommend hyper-distension of the abscess-sac with carbolized water or carbolized air. A weak solution of nitrate of silver has also been recommended for this purpose.

**MEDICATION.** Cold abscesses require the exhibition of arsenicum jodatum, calcarea jodata, baryta jodata or other of the iodine compounds. The general system must be supported by a liberal, varied diet, fresh air and exercise, cod liver oil and petroleum emulsion. Milk, fresh from the cow, beef peptonoids, and other nitrogenized foods should be administered to strumous children in connection with the proper constitutional remedy, these being usually the sufferers from this type of abscess. Sulphur, tuberculinum, thuja, psorinum, calcarea carbonica, silicia and calcarea sulphurica may be demanded in individual instances, depending upon the dyscrasia of the patient.

**Residual Abscess.**—This is a form of abscess, tubercular in character as a rule, that is seen in connection with operations upon joints, diseases of the vertebræ, and of the bones at the point of union of the shaft and epiphyses. They are also observed as permanent abscesses from enlarged lymphatic glands. They are due to the presence of tubercle bacilli in many cases, while in others the presence of feebly nourished and extensive masses of cicatricial tissues is the responsible factor. They may last for months, even years, but if thoroughly evacuated, the cavity being subsequently treated to antiseptic, stimulating injections, washings or packing, are readily curable.

The constitutional treatment is the same as is required in cold abscesses and in the chronic variety of circumscribed inflammatory abscess. Supportive diet, proper hygienic and sanitary measures, and the exhibition of antipsoric remedies, depending upon the dyscrasia of the individual patient, will assist in the cure. Especially valuable are sulphur, silicia, calcarea and the iodides of arsenicum and baryta.

## CHAPTER XXI.

### ULCERS.

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**Definition.**—An ulcer has been described as a solution of continuity of any portion of the external or internal surface of the body. It is usually due to inflammatory process and is characterized by the formation of a sore or chasm the result of the destruction attending thereupon. Following upon acute inflammation there is a combination of destruction of previously existing tissue and of that depending upon the nutritive and formative changes belonging to the inflammatory state. Structures that have undergone inflammation degenerate, liquefy and are thrown off as minute particles of necrosed tissue, molecular death of the structures encompassed in the ulcer site having occurred as a result of such inflammation.

The terms ulcer and sore have long been used synonymously. Strictly speaking, a sore is but the result of an ulcerative-process and so long as this is going on actively the process is that of ulceration and the term ulcer is more appropriate. When, however, this process is discontinued and all the destruction has occurred that is to occur, in other words, when the ulcerative process has been abridged and held in check by nature, the open wound which is left is called a sore. The distinction is a fine one and of no practical value.

**Varieties.**—A rapidly spreading ulcer is denominated phagedenic; if gangrene sets in, causing quick spread of the ulcerative process with off-throwing of considerable masses of tissue, it is called a sloughing ulcer; if the two processes are combined the term sloughing-phagedena is applied. Ulcers are called crescentic when they are crescent-like in shape; are denominated round when they are circular and sharply cut; are called constitutional if they are due to a debilitated state of the general system; are denominated varicose when they are seen in association with varicose conditions of the veins; are termed indolent when they are unusually sluggish and unresponsive to treatment; are known as eczematous when they are seen in association with eczematous conditions of the skin and appear as intensely irritable though comparatively superficial affections.

Ulcers are also classified, depending upon their pathological nature, as syphilitic ulcer, tubercular ulcer, rodent ulcer, lupus, epithelial, carcinomatous and scirrhus. Some of these types are considered in the sections treating of the surgical conditions of which they are but a phase.

**Etiology.**—As will readily be inferred the causes of the various types of ulcers mentioned will depend in good part upon the general systemic condition of the patient and the pathological states upon which they directly depend. Simple traumatic ulcer arises from a solution of continuity of surface tissue from injury. A sharp blow upon some portion of the body where the skin lies immediately over bone, as, for instance, the dorsum of the hand, the tibia, or the patella, is sufficient to

cause molecular death of the soft tissues by virtue of the crushing they receive between the bone beneath and the instrument imparting the injury, with the result that necrosis of the injured structures quickly ensues. There is pain, slight edema and infiltration, some inflammatory action, and early molecular death of bruised parts. These are surrounded by a circle of inflammation, this being nature's barrier against infection of adjacent structures by the pyrogenous elements liberated in the decaying or dead integument and connective tissue. Within a few hours, or a day or two at most, the injured structure becomes soft, pultaceous, slightly elevated above the surrounding structures, and there is a discharge of serous or sanious liquid. It is only when a dead tissue becomes infected from without, or within, that pus appears. As the necrosing process is abridged by nature's efforts the symptoms of surrounding inflammation subside, the dead mass, be it large or small, is liberated and thrown off in the way of liquefied tissue, or it may separate in flakes or sloughs. Should infection have occurred, by whatever means, there will also be an escape of pus from the ulcerative site.

**Acute Inflammatory Ulcer.**—Ulceration may be the result of infection, usually beginning as a small central spot of inflammation which subsequently shows as a pustule. The original site may be a hair follicle or sebaceous gland, the surrounding tissue becoming infiltrated and softened, a moderate degree of inflammation spreading out symmetrically, or irregularly, as the case may be, over an area of variable size, from that of a split pea to the size of a silver dollar or larger. The inflamed mass becomes pultaceous and necrosed, from strangulation of its circulation, from the peptonizing influence of the infective cocci, or both, with the result that the tissues liquefy and discharge as an ichorous fluid that is more or less flaky and shreddy, in some instances considerable-sized masses of superficial tissue being separated in sloughs—the process leaving a superficial inflammatory sore which subsequently heals by granulation and cicatrization without unusually prolonged course.

**Chronic Inflammatory Ulcer.**—Perhaps the most troublesome type of ulcer that is met with by the surgeon is the chronic inflammatory ulcer of the leg observed in elderly subjects, in persons whose personal hygiene has been vicious, whose habits are intemperate and systems vitiated by unwholesome food, unsanitary modes of life, neglect of personal cleanliness and the ordinary observance of laws of health.

The lower third of the leg is the usual site of the chronic inflammatory ulcer. It begins much as does the acute inflammatory ulcer just described, but because of the lowered vitality of the tissue and the previously unhealthy state of the skin, which has usually been varicose or eczematous, the ulcer when formed does not heal but remains as a chronic, irritable, inflammatory wound, with a considerable area infected and inflamed surrounding it. It is to this ulcer to which the term varicose has long been applied. As a matter of fact the veins are not affected in the process, and therefore, the term is a misnomer. Because of the degree of inflammation and infiltration that is present the neighboring veins and capillaries are enlarged, and because of the feebleness of the circulation of blood therein there is imparted to the surrounding structures a bluish appearance, from which the term varicose ulcer has arisen. This type of sore is more often seen in subjects whose circulation is feeble, whose



heart action is bad and whose venous circulation is not of the best, consequent varicose conditions of the surface veins being elsewhere observed.

**SYMPTOMS AND COURSE.** The chronic inflammatory ulcer starts from a small abrasion of the skin, from eczema, an insignificant wound produced by a pin scratch, a scratch by the finger-nail, or other slight traumatism. From these points inflammation occurs. The surrounding skin becomes somewhat reddened, the part itches, burns, and is usually somewhat painful. These symptoms cause the patient to rub or scratch the inflamed part, with the result that further injury is inflicted, capillary stasis resulting therefrom, with eventual down-breaking of the stagnated fluids and softening structures.

This type of ulcer is most commonly seen on the inner surface of the leg a short distance above the ankle. It may appear on the outer aspect or other portion of the limb. The area of edema in these subjects may extend over several square inches of surface, the open sore may be the size of a silver dime or as large as the palm of the hand, its edges may be clean cut or ragged, it may be sluggish, indolent, or acutely irritable, it may cause the patient a good deal of suffering and pain, with disturbances of the general system, or it may give him but trifling inconvenience. In fleshy subjects and those whose skin is generally unhealthy and whose habits are uncleanly this type of ulcer becomes exceedingly offensive and disgusting. In very thin subjects, those of scrawny habit and hydrogenoid constitution, there may be but little discharge, but slight degree of surrounding inflammation and infiltration and but insignificant impairment of the general health.

The course of this type of ulcer is essentially chronic. In some cases it lasts for years and is wholly incurable. In others the sore will respond readily to treatment, recovering fairly promptly, only to break down again after months or years, eventually becoming incurable. In exceedingly foul cases in subjects of the drink habit or those predisposing to nephritic ailments a septic state may supervene, this becoming serious, even destroying life. Subjects of feeble heart action and varicosity of the veins are also suited subjects for constitutional complication. While the chronic eczematous ulcer is in itself rarely responsible for a fatal issue yet the pathological states upon which it depends are often aggravated by the local process and thus rendered more dangerous. In several cases occurring under the author's observation a fatal issue seems to have been closely related with chronic, almost malignant, ulceration of considerable area of superficial tissue on the lower leg.

**Syphilitic Ulcers.**—The breaking down of a syphilitic gumma results in a syphilitic ulcer. The history of this type of ulcer is the formation of a surface gumma, the skin becoming intensely congestive and sensitive over its most projecting part, with an inflamed margin at the outer edges of the gumma, the central portion sloughing, leaving a sharply acute, wash-leather appearing sore. This ashy-gray slough occupying the cavity of the ulcer is undermined, softened and separated, leaving, in many instances, a biscuit-shaped cavity. When the gumma begins to break down the process is very rapidly completed. There is less of surrounding infiltration and inflammation than with the inflammatory ulcer. There is a preceding history of syphilis and the ulcer will be differentiated from the chronic inflammatory type by the fact

that its edges are sharply cut, that it is a deep sore, that there is no preceding eczema or varicosity, and that the destructive process is limited to the gummatous tissue, excepting in unusually malignant systemic infection, when it may be enlarged to perhaps twice the size of the original gumma before nature is able to throw out her barriers against the ulcerative process.

**Gangrenous Ulcers.**—Gangrenous ulcers have been sufficiently described in the chapter on gangrene. They may be of the dry or moist variety, they may depend upon senility, diabetes, traumatism, ergotism, frost-bites, local innutrition, and blood poisoning states. Lupus is discussed separately and it is not considered necessary to make further reference to it in this connection.

**Scorbutic Ulcers.**—Ulceration that goes with scurvy bears essential characteristics. It depends upon the constitutional state belonging to this disease, a peculiar feature of which is the effusion of a fibrinous exudate into various tissues. This seems to be capable of becoming feebly organized and permeated by newly formed vascular channels. When this fibrinous exudate is thrown out in the gums it causes spongy swelling of this tissue and the tumefaction and induration to the muscular tissues result in the formation of scorbutic nodes. If the effusion peculiar to scurvy is exuded upon the surface or lodged in the corium it is liable to soften and liquefy, resulting in the formation of scorbutic ulcers. These are distinguished by lividity of color, irregularity of edges, doughiness of immediately adjoining tissues, and the formation of a spongy, dark-colored, adherent crust, emitting an offensive odor and retaining congested blood and fibrinous exudate beneath it. When forcibly removed free bleeding from underlying granulating tissues follows. Fortunately, scorbutic ulcer is rarely seen at the present day. In former years, when scurvy was much more common than now, it was a commonly observed condition.

**Treatment of Ulcers.**—The acute inflammatory ulcer will require but little in the way of surgical treatment. If due to infection the infected area should be incised and treated to the local application of crude carbolic acid or other escharotic. If a slough forms it should be removed as promptly as possible and the ulcer treated upon general antiseptic principles. Remedies that will be found of value in relieving the inflammation seen in association with acute ulcer are those applicable to inflammation elsewhere, as aconite, ferrum phosphoricum, apis, belladonna, mercurius, hepar, silicia, and others as indicated.

**TREATMENT OF CHRONIC INFLAMMATORY ULCER.** The chronic inflammatory ulcer is one of the betes noirs of surgery. As has been stated it is observed most often in debilitated subjects and in those whose systems have been rendered unwholesome by alcoholic and other abuses, consequently the material to be operated upon is of the worst. Palliative treatment will consist of the application of astringent lotions, as a weak lead solution, boracic acid, carbolic acid, zinc ointment, calendula, hamamelis, arnica, cantharis or other selected agent. In rare cases it may be necessary to apply the rubber bandage from the foot to the knee. This is not available unless the ulcer be well healed; and even then unless the pressure be evenly distributed and the sore carefully guarded by antiseptic gauze injury instead of benefit will result. If it be possible to

so guard the ulcer that it may be kept in sight, and the dressing be protected from contamination by its discharge, a very satisfactory treatment will consist of the close application of a starch bandage from the toes to a point two or three inches above the sore, the latter being exposed to view by an opening in the bandage made for the purpose. If this bandage be evenly applied that degree of rest of the leg that is necessary will be secured, the sore being all the while open to inspection and treatment. If there be a good deal of ichorous discharge this form of bandage is not applicable, as the protective lint that is first applied will become soiled from the discharges, resulting in further irritation and destruction. Boracic acid fomentations, made by wetting boracized lint in sterilized water and applying it under the rubber bandage, is an excellent dressing. Rest, however obtained, is the most important feature. The limb should be elevated slightly above the horizontal, the wound kept perfectly clean, the general system supported by proper constitutional remedies, liberal diet and wholesome hygienic measures, if the best results are to be secured. As in bed sores the application of galvanism will be found advantageous in suited cases.

*Medication.* Arsenicum is more applicable to the eczematous state—the infiltration, the weak heart, the burning, itching and general state of the case—than any other single remedy, in a large number of instances.

Apis will be found beneficial when the inflammation is acute, the tissues are much swollen and are of an angry, bright-red appearance.

Rhus tox. suits old eczematous cases with nightly aching, rheumatoid pains, worse upon changes of the weather, vesication surrounding the sore, and weak heart from the rheumatic diathesis.

Kali muriaticum is an excellent remedy for the typical eczematous ulcer.

Hamamelis, lachesis and secale will be found especially useful when there is a good deal of varicosity.

Hepar, silicia, and mercurius are worthy of consideration in connection with unwholesome states of the sore, ichorousness of discharge and indolence of the ulcer.

The syphilitic ulcer will demand anti-syphilitic treatment—mercurius, the various preparations of kali, thuja, kali muriaticum and sulphur being required.

Natrum muriaticum and natrum sulphuricum will be found very helpful when there is a good deal of dry scurfing of the skin and local integumentary irritation.

**Bed Sores.**—In protracted illness or long confinement from surgical causes patients may be subjected to a destruction of the soft tissues lain upon for a considerable length of time, resulting in traumatic ulcers that go under the name of bed sores. These are more commonly observed from the sacrum, coccyx and hip-joint, from long continuance in the dorsal decubitus. They are especially likely to be the result of a combination of long continued pressure upon these tissues, and uncleanness, as from urinal saturation, the discharge of liquid feces and their contact with the tissues likely to be affected by bed sore, and which are not promptly cleansed away, and also from continued perspiration of these parts with integumentary desquamation and gross neglect of proper personal hygiene.



Bed sores are commonly seen in typhoid fever, pneumonia and other protracted illnesses. They may occur in surgical practice when a patient is confined to his bed over a long period of time, from whatever surgical cause. In some subjects they appear promptly, even before the surgeon is solicitous of their appearance. In other subjects severe and protracted illness may be borne without the appearance of local inflammation of parts lain upon. They are more likely to occur early in elderly subjects, in those who are very spare, in whom but little muscular tissue protects the skin from pressure between the bed and the bones, and in just the opposite type of subjects, those who are very fleshy, whose weight causes necrosis of the integument, which condition is encouraged by the perspiration commoner to fleshy people.

**SYMPTOMS AND COURSE.** The first symptom of bed sore is a simple inflammation and tenderness of the skin at the point pressed upon. A slight abrasion may result from crumpling of the bed clothes or night-wear, causing sharp pressure at a particular point, or it may arise from the presence in the bed of a crust of bread or other offending substance that serves to abrade the superficial integument. From even insignificant traumatism inflammation quickly spreads to the surrounding tissues, and within a day or two from the first evidence of redness and inflammation a large sore may have formed. In special cases bed sores may be as large as the palm of the hand or larger, as sharply cut as the ulcer of syphilitic gumma, and one-half an inch or more in depth. In one instance observed by the author the hip joint was exposed, the open sore being large enough to have accommodated a water-biscuit. When occurring over the sacrum an area of necrosis several inches in extent may quickly result, almost the entire sacrum being denuded of its integumentary and muscular coverings. In unusually severe cases the bones may be exposed, being denuded of their periosteum, and in extreme instances necrosis of bony tissue follows.

**TREATMENT.** With proper hygienic measures a bed sore should never occur. When a patient sets in for protracted illness or long confinement in bed frequent change of position should be made in order that local necrosis be avoided. Bathing of the endangered skin should be practiced twice or oftener in the twenty-four hours. The addition of alcohol, ether, calendula or borax to the bath is often grateful and prophylactic. Arnica is especially an excellent remedy, to be applied in the bath in very weak dilution of the tincture. It goes without saying that the bed upon which the patient lies should be kept smooth and free of foreign substances that irritate the skin. The mattress should be reasonably firm, in order that the pressure of the body may be evenly distributed. Especial precaution should be taken that urination and defecation be effected without irritating contact with parts lain upon, when, if bathing be practiced as directed, there will be little, if any, danger from this cause or from the irritating effects of perspiration.

If a local part shows redness, pain and commencing inflammation efforts should be made to relieve pressure thereupon by distributing the support of the body to other parts as yet not irritated. This may often be accomplished by flat pads of quilted cotton several inches or a foot or two in size, sufficiently thick to lift the irritated part from the bed and sufficiently large not to cause discomfort to portions of the body lying



Figure 1.  
Ulcerating Initial Lesion of Under-Lip.  
(Observed in a Virgin.)



Figure 2.  
Serpeginous Ulcer on Oval Cicatrix.

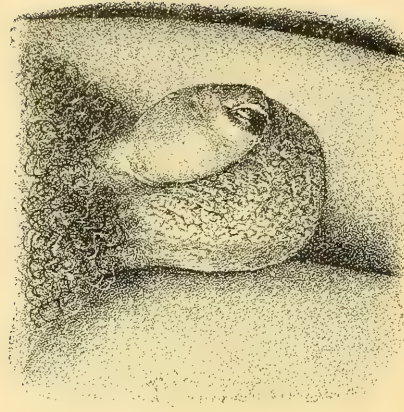


Figure 3.  
Indurative Edema of Penis and Scrotum.

## PLATE VI.—VARIETIES OF SYPHILIS.

## CHAPTER XXII.

### SYPHILIS.

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**Synonyms.**—Syphilis; lues venerea; pox; bad disorder; morbus gallicus, etc.

**Definition.**—Syphilis is an infectious constitutional disease, chronic in its course, having many of the characteristics of the exanthemata, and supposed from analogy to be due to invasion of the system by a specific micro-organism the nature of which is as yet undetermined. In addition to its being inoculable syphilis is directly transmissible by inheritance from subjects who have acquired it by inoculation. The fact of these two methods of transmission gives rise to the use of two terms, acquired syphilis and hereditary syphilis, which represent pathological processes essentially the same yet differing enough in their clinical course to require separate consideration.

**History.**—There still exists wide variance of opinion as to the antiquity of syphilis and there seems to be little hope of arriving at a well-grounded decision in the matter, from the fact that proof of antiquity must, from the nature of the case, rest upon the very uncertain evidence afforded by (1) ancient literature, and (2) the discovery of osseous remains whose antiquity admits of no doubt whatever, and which exhibit evidence of lesions present in syphilis and in no other disease or condition. Syphilographers are divided into two classes in their opinions upon the origin of the disease. One class, basing its opinion upon the evidence afforded by certain ancient Chinese, Japanese, Egyptian, Hebrew and other manuscripts, and accepting as reliable evidence numerous examples of somewhat characteristic bone lesions which have from time to time been exhumed from places of supposedly prehistoric sepulture, claims for syphilis a very ancient and even prehistoric origin. This wing of the profession includes many eminent men whose opinions necessarily carry much weight; nevertheless, it must be frankly stated that none of this evidence can be accepted as conclusive. The facts that ancient literature admits of such varied interpretation, that the statements made are general in their nature, never describing with accuracy even gross appearance, that the authors were not skilled in diagnosis, while other diseases somewhat resembling syphilis probably existed then as to-day, all contribute to weaken the chain of evidence. Turning to the specimens of osseous remains which are referred to as evidence that syphilis existed in prehistoric time doubt finds opportunity to creep into every case, doubt either as to the actual prehistoric origin of the specimen or as to the positively syphilitic nature of the lesion found. Notwithstanding the fact that there is a total lack of scientific accuracy in all these evidences of the ancient origin of syphilis it must be admitted that the very mass of evidence and the fact that it comes from the four quarters of the globe make it more or less convincing.



That wing of the profession which values no evidence short of scientific demonstration dates the origin of syphilis near the end of the fifteenth century, about the date of the discovery of America by Columbus. Whether members of Columbus' expedition acquired the disease in the new world and carried it back to Europe, or whether just about this date circumstances were such that the disease received attention never before granted it, or whether from some unknown cause it became more widely distributed than ever before, will probably never be known.

It is a matter of authentic history, however, that some of Columbus' party were treated for the disease, and that during the next few years there occurred throughout Europe a veritable epidemic of syphilis. Not until this time did it become the subject of careful medical investigation and writing, and not until then did it take its place as a well recognized disease; although even down to a comparatively recent period other venereal disorders (chancre and gonorrhea) have been confounded with it by many medical men. From the end of the fifteenth century to the present day advance in all branches of medicine, save, perhaps, therapeutics, has been rapid, and has in the main proven to be toward stable improvement; and this advance has nowhere been more marked than in our knowledge of the various manifestations of syphilis. To mention the names of Paracelsus, Pare, Boerhaave, Hunter, Bell, Ricord, Bassereau, Lacereaux, Diday, Parrot, Fournier, Profeta, Virchow, Heubner, Erb, Kaposi, Hutchinson, Boeck, Bumstead, Taylor, Keyes, Morro, Piffard and Lustgarten as being liberal contributors to the general fund of information upon this subject is only to single them out as the more prominent ones among many hundreds of illustrious men who have by patient study and observation collected and classified facts which, when taken together, comprise a knowledge of syphilis but little less than a science.

**Distribution and Frequency.**—From the fact that syphilis is, as a rule a venereal disease, its prevalence in a community is a fairly good criterion of the standard of morality of that community. Nevertheless, the frequency of syphilis insontium must not be lost sight of, and by reason of the ease with which the disease is communicated to the innocent and the guilty, and, the rapidity with which the syphilitic may travel from one extreme of the globe to the other, it has become rooted in every country and province and is to be encountered in every city, town and hamlet upon earth. Its greatest frequency is in those large cities which are great centers of commerce, and along the most frequented lines of travel. The presence of the army, the navy, the occurrence of the "fair" and the "exposition" always bring an increase of venereal diseases, syphilis with the rest. While rural districts are by no means free from taint the fact that license and debauchery are of necessity much less prevalent than in the city, where identity is so easily concealed, gives syphilis far less opportunity for propagation, and from this it often follows that where the urban physician meets hundreds of syphilitics his rural colleagues have opportunity to observe few if any during an extended experience. In uncivilized lands the explorer, the traveler and the merchant has each done his share in introducing the virus, until now there is no region so remote that it has not its examples of some of the manifestations of lues. Climate, soil, temperature and elevation have, so far as is known, absolutely no direct influence upon the frequency of syphilis. Station in life

does not in itself carry with it the least influence toward immunity or predisposition; the poor, the rich, the gentleman of leisure, the day laborer and even the dignified professional man, each has only to become "the victim of unfortunate circumstances" in order to become the victim of syphilis.

**Etiology.**—As has been intimated in the definition of syphilis it is proper, basing judgment upon its close analogy to certain other diseases, to regard it as dependent upon the presence in the system, either by inheritance or inoculation, of a micro-organism of some kind. At present the nature of this micro-organism, if such exists, is unknown, and the only reason for expecting an announcement of the positive demonstration of a germ as the cause of syphilis is the fact that such germs have already been demonstrated in chronic infective granulomata, tuberculosis, leprosy and glanders. Klebs, Bermann, Birch-Hirschfeld and many others, more especially Lustgarten, have observed various baccilli and cocci which were suspected of being constantly present in syphilitic lesions, and perhaps causative of them. A critical survey of their work and discussion of their various claims would occupy a volume; but it may be said in few words that none of the important requirements of a demonstration have as yet been complied with. The organisms found have been few in number, not constant in all syphilitic lesions, and found in patients who were not the subjects of syphilis.

It may be said, *en passant*, that in entertaining the hypothesis that syphilis from its resemblance to the infective granulomata probably depends upon a similar cause it must be remembered that syphilis appears to be an hereditary disease, in the strictest meaning of the term, and that in this respect it distinctly does not resemble tuberculosis and other diseases now known to depend upon the presence of specific micro-organisms.

Entering also into the etiology of syphilis the factors brought by the patient himself must be considered, and upon this subject authorities may speak with some confidence; for it is quite clear from clinical experience that virus from the same source inoculating different individuals does not by any means produce lesions of equal severity. Attempts have been made to explain this peculiarity, not only of syphilis but of all the infectious diseases, upon the hypothesis of variable dosage. Proof of this position is necessarily very meagre, while abundant evidence is at hand that the course of the disease is often influenced by certain demonstrable conditions of the infected person, and, perhaps, certain conditions which are as yet undemonstrable. Considering large numbers of cases it appears that patients who are the subjects of constitutional weakness, of tuberculosis, malaria, alcoholism, the very aged, and the very young, are likely to suffer more severely from the ravages of syphilis than are those who are robust, temperate, and in middle life. Notwithstanding this generalization, however, every now and then there will be encountered a patient who has all the appearances of health and vigor, who lives an abstemious life and yet who, in spite of every effort toward good care and treatment, develops a severe and persistent form of the disease. These cases are explained by some upon the hypothesis that a large proportion of the human race are more or less tainted with hereditary syphilis and, therefore, in a measure protected; but that those unfortunate individuals who suffer most severely are members of families which have escaped infection

or in which the disease has "run out." Taking into consideration similar peculiarities of other contagious diseases it appears more logical to suppose that there exist in some persons certain structural peculiarities apart from actual diseased conditions that render them more able or less able, as the case may be, to withstand the onslaught of the germ of syphilis, and that this peculiarity rather than the presence or absence of hereditary taint accounts in a measure for the variable type of acquired syphilis.



## CHAPTER XXIII.

### ACQUIRED SYPHILIS.

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**Methods of Transmission.**—Syphilis is transmitted by bringing some of the virulent secretions of a syphilitic individual into actual contact with an abraded surface upon a non-syphilitic individual, by inheritance from parent to child, and by transmission from fetus to mother through the utero-placental circulation. It never arises *de novo* nor from gonorrhea, chancreoid or any other disease.

The virulent secretions which may act as conveyers of the contagious element are: (a) the secretions from any initial lesion or chancre and (b) those from any of the moist secondary lesions either of the skin or mucous membrane. The discharging chancre, the moist papule, the pustule, the condyloma, the mucous patch, and the early ulcer all secrete a fluid which when brought in contact with an abraded surface upon one non-syphilitic, be it only in microscopical quantity, will develop an initial lesion followed by the regular constitutional symptoms of syphilis. The blood of the patient in the early, active stages of the disease, when experimentally inoculated, produces syphilis; but there is some question whether the same result follows inoculation with blood from patients having latent syphilis, i. e., during the intermission of the disease. It is quite generally held by syphilographers that the physiological secretions, as milk, urine, tears, saliva and perspiration, when free from contamination by the secretions of moist specific lesions, are incapable of conveying the disease. Semen, when inoculated, does not produce syphilis, although it is quite certain that the spermatozoon may convey it to the ovum and therefrom to the offspring without the mother's having been infected. The syphilitic mother develops an ovum that results in a syphilitic child even when impregnated by a healthy father. The secretions from non-specific lesions upon syphilitics are, if free from blood, generally admitted to be innocuous, as are the secretions from tertiary lesions of all kinds. On this subject Fordyce proclaims that "the result of inoculation experiments is in accordance with everyday experience, which teaches us that late lesions are, as a rule, neither inoculable nor transmissible by inheritance, and that such patients may acquire a syphilitic reinfection. The views regarding the infectiousness of the late lesions of syphilis must not be taken too absolutely, as a number of good observers have reported instances both of inoculation and hereditary transmission of syphilis."

From these general characteristics of syphilitic infection it follows that there are four methods by which syphilis may be acquired: 1st, Direct Contact. 2nd, Mediate Contact. 3rd, Hereditary Transmission. 4th, Maternal Infection.

**DIRECT CONTACT.** From the fact that over ninety per cent. of syphilitic infections occur during the sexual act and about the genital region the disease is justly looked upon as essentially a venereal disease. Nearly all the cases in which it is venereal in origin acquire it by direct contact.

A slight abrasion exists upon the mucous membrane or skin of the genital organs of the recipient, or is produced there during the sexual act and upon it is deposited some of the secretion from a mucous patch, chancre, condyloma or other moist lesion upon the donor. The same result may follow unnatural practices in which case the avenue of entrance of the contagious element may be through solutions of continuity about the arms, breasts, lips, tongue, mouth, pharynx, etc. Aside from venereal acts syphilis may be directly communicated by kissing, biting, sucking, as in breast-drawing or sucking a wound. Physicians and nurses not infrequently acquire syphilis directly while handling their patients, in making examinations and conducting obstetrical cases.

**MEDIATE CONTACT.** This covers a very wide field, since the possible agents for conveying the virus include all the objects with which we come in contact during our daily life, from the chalice handed us by the priest to the traditional closet-seat, which has been instrumental in preserving the peace of many a family. Handkerchiefs, towels, bed-linen, wearing apparel, knives, forks, spoons, nursing-bottles, cigar and cigarette-holders, syringes, catheters, the surgeon's instruments, his hands, the dentist and his instruments, the barber and his tools, are each more or less frequent carriers of syphilis to the innocent (*Syphilis Insontium*). Vaccination may be a cause of infection either through the use of "humanized virus" from an unknown syphilitic, the use of unclean instruments, or the vile habit of the vaccinator who moistens the point with his saliva when he is the subject of mucous patches or ulcers. Not all cases of inoculation by mediate contact are innocent in their nature; for the healthy vagina or penis may be simply the depository of a virus left by a former visitor, this virus falling upon an unabraded surface and only finding opportunity for development when another unfortunate individual appears possessing solutions of epithelial continuity in the proper location.

**HEREDITARY TRANSMISSION.** The subject of hereditary transmission will be discussed under hereditary syphilis.

**MATERNAL INFECTION.** This term is used to describe the process which is supposed to take place when a woman acquires syphilis through the agency of her impregnated ovum or its resulting fetus, without the development of a chancre. The subject is one upon which a great deal of doubt is entertained, and as the limits of a chapter like this are altogether too narrow for proper discussion it will be dismissed with a brief statement of the facts as they appear, remembering that the whole matter is still sub judice.

There are said to be two methods by which a woman past the age of puberty can acquire syphilis without having a chancre. First, a syphilitic father impregnates the woman and she acquires the disease from her syphilitic fetus through the utero-placental circulation. Second, impregnation not following the coitus, she may become infected from the spermatozoa.

Two facts which seem pretty well established will illustrate the difficulty in solving the questions involved. First, a mother apparently free from syphilis, bearing a syphilitic child by a syphilitic father never acquires syphilis from nursing her child. (Colles Law.) Second, a woman who acquires syphilis as late as the seventh month of gestation may transmit it to her child through the utero-placental circulation without the



production of chancre, and, this being the case, it is reasonable to suppose that the reverse can take place. These two facts favor the theory outlined. But, upon the other hand, it must be remembered that experiments have pretty thoroughly proven that semen will not produce syphilis when inoculated upon the adult.

**Immunity.**—Immunity from syphilis is a peculiarity which seems to be the heritage of the whole animal kingdom, man alone excepted. It is true that from time to time during the past fifty years numerous observers, among whom are Auzias, Turenne, Bradley, Legros, Martineau and Hamonic, have reported isolated cases in which they apparently successfully inoculated guinea-pigs, monkeys and a kitten; but as their experiments are open to many criticisms, and as numerous able observers have repeatedly failed to verify them and have become convinced of the impossibility of animals becoming the subjects of syphilis, the general statement may be accepted that animals are immune. In the human family the acquisition of the disease at once brings to that individual immunity against reinfection, except in a very small number of cases in whom reinfection has been known to take place. This immunity begins in the primary stage and lasts through the active stages and for an unknown period thereafter. It is supposed to be due to "tissue products of the virus in the circulation," a statement which coincides with the present view of the pathology of contagious diseases, but which has little else upon which to stand. There are to be found in the literature of syphilis some half a hundred reports of cases of reinfections occurring after the active symptoms of syphilis had subsided. Many of these cases were observed by such eminent syphilographers as Diday, Jonathan Hutchinson and Koebner, and yet doubt still exists as to the accuracy of their observation of a phenomenon whose proof is one of the most delicate tasks imaginable. Upon this subject Keyes says: "Personally, although I have several times treated patients who had been through long courses of mercurial treatment for alleged syphilis, and came to me with true syphilitic chancre, and have seen other cases of alleged chancre in patients whom I had known to be formerly syphilitic, I have been always able to unravel the points of difficulty to my own satisfaction; and I can honestly state that I have never seen a case of syphilitic reinfection to recognize it. While, then, a secondary true syphilitic infection is possible, even while the subject bears the marks of late tertiary disease, such infection is eminently exceptional, and allowance must be made in the reported cases for the possibility of chancroid accompanied by some eruption as a coincidence; second, ecthyma mistaken for syphilis, after which the first true syphilitic infection might pass for a second; third, false chancre, indurated mucous patch; and fourth, cases of tertiary ulcer faultily diagnosed." The hereditary, no less than the acquired, form of syphilis affords protection to the subject, and beyond this, there are other circumstances which are recognized as rendering their subjects immune and that without their having been the subjects of syphilis in an active form. If a healthy woman be impregnated by a syphilitic she may fail to develop any of the recognized evidences of syphilis; at the same time she may give birth to a syphilitic child, or one who, while healthy at birth, develops hereditary syphilis at a later period; and yet at the same time she is incapable of acquiring syphilis by nursing her child or even by experi-



mental inoculation. (Colles' Law.) This immunity, acquired without the manifestation of any of the ordinary symptoms of syphilis, has been observed in thousands of cases. Caspary, Neumann and Fenger have even inoculated these patients without success. Another instance of the same protection is evidenced in some of those children of syphilitic parents who are born and remain healthy, yet will not acquire the disease even by inoculation. (Profeta's Law.)

**Clinical Course.**—For convenience of description syphilis is divided into three stages: Primary, secondary and tertiary. These stages are separated from each other, however, by fairly definite periods of time, which by some authors have been described also as stages of syphilis. The former division has become so common, and is marked by such radical differences in the characteristics of the various lesions, that it will be adhered to in the following description.

After accidental, venereal, or other inoculation by syphilitic virus there occurs a period during which no symptoms are manifest, known as the period of primary incubation. This is followed by development of a sore at the site of inoculation, called the primary sore, initial lesion, or, more commonly, chancre.

The period of quiescence which follows inoculation and precedes development of the chancre is somewhat variable, but in the large majority of cases its limit is from two to four weeks, twenty-one days being the average. Then there begins a development of hyperplastic tissue at the site of the original inoculation, resulting in some of the numerous forms of chancre. This chancre is apparently not a severe lesion; its course is not very protracted, ulceration is not a very marked feature, and healing takes place in the course of from three to six weeks, leaving, however, an induration, which gradually undergoes absorption. Before the chancre has healed, and usually shortly after its first appearance, there develops an enlargement of the lymph nodes in its immediate neighborhood—local adenopathy. The presence of adenopathy, together with the chancre, constitutes the primary stage of syphilis.

From six weeks to three months after the appearance of the initial lesion an eruption begins upon the skin, accompanied or preceded by general enlargement of the lymph nodes of the body, general adenopathy, and the appearance of erosions and superficial ulcers upon the mucous membrane of the mouth and throat, together with some falling of the hair in various parts of the body—alopecia. This group of symptoms is known as secondary syphilis, and the eruption may assume various forms which will be described later.

The period of time between the appearance of the initial lesion and the development of the rash and general adenopathy is known as the period of secondary incubation. During this period, or at about the time of appearance of the rash and adenopathy, there is likely to develop a mild form of fever, known as syphilitic fever. This fever is not marked by a high temperature, the usual range being 100 degrees to 102 degrees at night. It is accompanied by headache, malaise, muscular and articular pains, and is usually relieved shortly after the general rash breaks out. The period of secondary syphilis, extending from the first appearance of rash to the final cessation of the superficial lesions, is very variable. In very mild cases it does not exceed three or four months,

while in others secondary lesions may occur and recur during a period of one, two, or even three years. The secondary stage is usually succeeded by a period of latency, or absence of all symptoms, which period may extend through the patient's life or may be brought to a close at any time from two to twenty years after the initial lesion by the development of certain deep-seated lesions which constitute tertiary syphilis. The general characteristic of all the lesions of syphilis, from the primary sore to the tertiary lesions known as gummata, is cell-hyperplasia; that is, the formation of new tissue rich in cell elements, but having great proneness to undergo early degeneration.

**Unusual Modes of Evolution.**—The foregoing synopsis in general the history of a large majority of cases of syphilis. No disease with which the surgeon is acquainted is subject to so many variations from the general rule as this, and there are many cases in which the harmony that ordinarily exists between the form of lesion and the date of its appearance is entirely destroyed, giving rise to a number of types described as irregular syphilis.

**BENIGN TYPE.** Benign, rapid syphilis, is a form of disease in which all the symptoms are mild. The termination is recovery at an early date, but such tertiary lesions as tubercles and gummata develop before complete involution of the papular and pustular eruptions of the secondary stage.

**MALIGNANT TYPE.** Malignant, precocious syphilis, is that form in which the disease is, from some cause or other, especially severe in its character and rapid in its development. It is usually characterized by a short period of primary incubation, marked adenopathy, and the early appearance of secondary eruptions, which soon give way to severe and rapidly destructive tertiary lesions, the whole process being accompanied by grave systemic disturbances, and not infrequently ending fatally at an early date.

## CHAPTER XXIV. PRIMARY SYPHILIS.

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**Primary Incubation.**—Primary syphilis is the term applied to that period of the disease which precedes any visible symptoms of general infection. It is manifested by symptoms which are entirely local in character, i. e., the initial lesion and its attendant glandular enlargement. The period which intervenes between the date of inoculation and the development of syphilitic chancre is unbroken by any appearance which patient or physician can detect as suggesting that any sort of poison has invaded the system. If an abrasion or crack of any kind existed, and it may be assumed that such did exist in every case, it heals perfectly and is usually either unnoticed or else forgotten by the patient. The time limit of this "calm" has been very carefully studied in large numbers of cases, and in a few instances very wide variations have been noted. For example, Hammond, Taylor, Diday and others have seen it as short as twenty-four to seventy-two hours, while in rare instances the other extreme has been recorded as reaching ten or eleven weeks. Since it is notorious that the statements of patients are untrustworthy, our best information upon this subject is obtained from cases of inoculation where dates were recorded; the extremes from this source are given as being from one to ninety days, the average being about twenty-six days. Figures which give extremes, however, must be looked upon as covering the possibilities, and the student and practitioner will do well to fix in mind that the first incubation period is from two to four weeks, the average being three weeks.

**The Initial Lesion.**—This invariably begins at the exact point of inoculation, and, practically, this may mean any possible portion of the surface of the body or of any of the accessible cavities. As would naturally be supposed, a large majority of chancres appear about the male and female genitalia; they are seen next in frequency about the mouth and face. In the male the most common situations are the balano-preputial fold, the mucous membrane of the prepuce, the surface of the glans, the meatus, the urethral canal and the scrotum. In the female the external genitals and the cervix uteri are favorite sites. Only rarely does chancre develop upon the vaginal mucous membrane. Extra-genital lesions are said to constitute from two to six per cent. of all chancres, their most frequent locations being about the anus, within the rectum or the mouth, on the lips, tongue, cheek and nipple. Physicians and surgeons may acquire chancre upon their fingers or hands.

The initial lesion is usually single, although if numerous abrasions exist any number of them may become infected and give rise to multiple chancres. In order for this to occur it is necessary that they should be inoculated at the same time, as syphilitic chancre is not auto-inoculable.

Numerous attempts have been made to classify the various forms of infecting chancres from their physical characteristics. Taylor, especially,





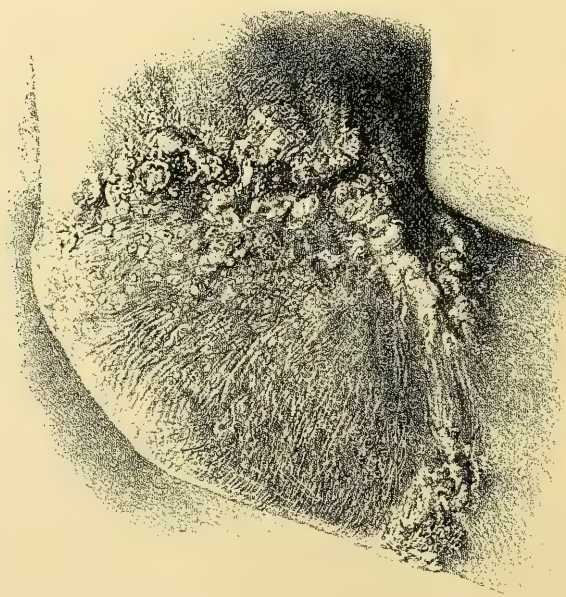


Figure 1. Infiltrated Gummata of Knee.

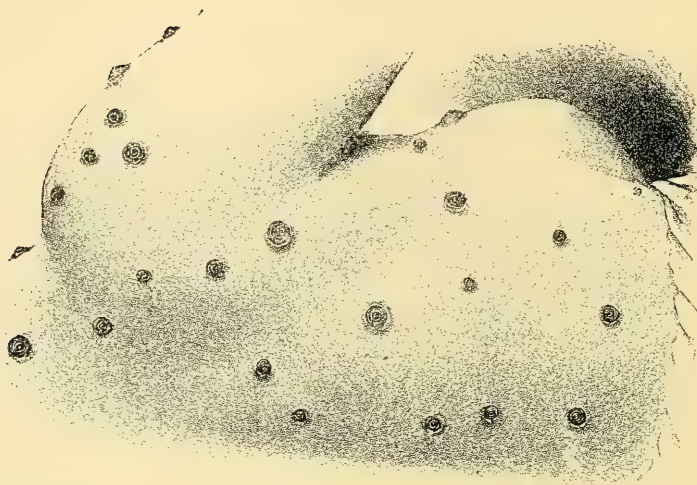


Figure 2. Rupial Syphilitic Pustules.

## PLATE VI, A.—VARIETIES OF SYPHILIS.

has described six forms which he has observed upon the female genital organs alone. His classification and description are excellent, but it appears quite probable that since the characteristics of the initial sore are dependent upon surroundings, and since the sore may occupy any portion of the body, the list of varieties of chancre can be indefinitely extended, much to the confusion of both student and practitioner. Therefore the simplest possible method is here adopted and three varieties which seem to differ enough to merit separate consideration are described.

**DRY PAPULE.** The first is the dry, scaling papule which begins in a very insignificant manner as a small, dull red, slightly elevated papule which tends to increase circumferentially, but does not ulcerate. It is usually met with upon a free surface and is frequently characterized by a slight tendency to scale. It is as a rule unique, is sometimes accompanied by a plate-like induration, and usually leaves a deep brown or purplish stain upon the skin.

**SUPERFICIAL EROSION.** The second is the superficial erosion, and is probably the most frequent form observed. It always occurs on the mucous membrane, and begins as a red spot somewhat deeper in color than the surrounding membrane. Later it loses its epithelium, presenting a slightly moist, smooth, raw surface, although it may sometimes be covered by a grayish film. While the superficial erosion is usually small it may attain the size of half an inch or even an inch in diameter. This form of chancre is sometimes multiple and is often free from induration; although if it is so located that it can be picked up between the thumb and finger a peculiar "parchment-like" hardness underneath may be detected. Occasionally a superficial erosion may be transformed into a mucous patch; or, on the other hand, it may on some occasions become indurated, thus forming a typical Hunterian chancre.

**HUNTERIAN CHANCRE.** The third variety is the deep chancre commonly known as Hunterian chancre. It presents a deep, ulcerating surface with elevated edges and is attended by marked induration. Its surface is usually foul and dirty-looking, and covered by a serous or sero-sanguinolent discharge. This form of chancre is generally the precursor of a more severe grade of syphilis, and it leaves a marked induration after healing has taken place.

"**MIXED CHANCRE**" is a condition arising from simultaneous inoculation with syphilitic virus and the virus from chancroid. It is characterized by the appearance of a sore which at first is likely to have all the characteristics of chancroid, but which later develops the peculiar induration accompanying syphilitic chancre. This peculiar condition has never been observed to follow inoculation by the virus from a purely syphilitic lesion, but appears not infrequently in cases of venereal origin where there is ample opportunity for the double infection to take place. It cannot logically be classified as one of the varieties of syphilitic chancre, but must be regarded as a syphilitic chancre modified by the simultaneous presence of the chancroidal process, or as a chancroid modified by the syphilitic process.

**DIAGNOSIS OF THE CHANCRE.** Since the diagnosis of syphilitic chancre is of such vast import to the patient there are certain general considerations relating to all forms of infecting chancre which should be carefully studied. The grand characteristic of syphilitic chancre is its induration,



which consists in an infiltration of the underlying tissues and a thickening of the vessel walls. It is possible for this condition to be absent or so slightly developed as to defy detection and yet the sore be syphilitic; but such cases must be extremely rare. It is far more frequent for non-infecting sores to become the seat of a somewhat similar induration as one of the effects of irritation and inflammation. The induration may be so slight that it can hardly be detected in the most delicate tissues, like those making up the prepuce, much less in such resisting structures as the cervix uteri and glans penis. It may lie beneath the suspected lesion as a definite nodule, or may be even so marked as to involve surrounding tissues in a hard mass. It is likely to be modified by the character of the tissue upon which it is located, being often slight in chancres of the glans penis and cervix uteri, and well marked in those of the foreskin, frenum, lips, nipple, etc. Induration may precede or follow ulceration or may exist independently of it, and in any case is likely to out-last other evidences of the sore, often persisting for two or three months. The "parchment-like" variety disappears soonest, even disappearing sometimes in so short a time as two weeks. In typical cases the sense imparted to the educated finger cannot be mistaken. It is a peculiar, elastic feel, which does not in the least resemble the doughy, boggy quality of the inflammatory induration. The induration of a specific sore is sharply defined and rarely shades off into the surrounding tissues, as does the hardness accompanying ordinary inflammation.

Ulceration is not a necessary feature of chancre, but may better be regarded as a very frequent accident. Its progress is usually very mild, often resulting in nothing more than a mere excoriation which readily becomes encrusted with scabs. If an ulcer forms it is usually round or oval, with smooth slanting borders that are never undermined as is the case with chancreoid. Pus is not characteristic, the more frequent exudate being pure serum or serum mixed with blood. Pain is absent unless the sore is irritated; healing is accomplished in the majority of cases without appreciable scar, although a brownish pigmentation frequently remains.

**LOCAL ADENOPATHY.** Syphilitic bubo is an enlargement of the lymph nodes in the immediate vicinity of the initial lesion which occurs during the second week of the chancre and persists for weeks or even months after constitutional symptoms have made their appearance. Since the chancre is most frequently found upon the genital organs the adenopathy is usually confined to the groins, one or both. In extra-genital chancre the site varies according to the course of the lymphatics leading from the sore. It is common for many nodes to enlarge, the favorite arrangement being one large node surrounded by a number of smaller ones, all of which have the characteristic induration of the initial lesion, free mobility, absence of pain, inflammation and suppuration, unless they are injured or irritated in some manner.

## CHAPTER XXV.

### GENERAL OR CONSTITUTIONAL SYPHILIS.

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**Application.**—This term is applied to all manifestations of the disease, no matter when or where they appear, which are consecutive to the chancre and its attendant local lymphatic enlargement. Consequently the term “general syphilis” is to be understood as including “secondary” and “tertiary” syphilis, as a strict adherence to the classification of all lesions between these two subdivisions involves much repetition and is even then defective. The secondary stage oftentimes shades into the tertiary so gradually that the exact point of transition cannot be determined, and in describing the numerous lesions of the constitutional disease a classification is chosen which is based upon the organs and tissues affected, the lesions which are early or secondary being considered in the first, and those which are late or tertiary in the last part of each division. Where doubt might exist the lesions which are considered as being tertiary will be mentioned.

**Secondary Incubation.**—The period of time elapsing between development of the initial lesion and appearance of the first symptoms which are recognized as positive proof of the establishment of general syphilis, i. e., the generalized skin eruptions, is termed the period of secondary incubation. The period of primary incubation, as has been said, is absolutely without symptoms. Not so with the second period, for the initial lesion and its attendant phenomena have not always disappeared even when the rash breaks out; beside which, evidences of dissemination of the infective element are not usually wanting. During the three weeks immediately preceding the appearance of the eruption the patient suffers from insomnia, headache, rheumatoid pains—especially at night—from marked lassitude and a feeling of melancholy. The appetite is poor, the skin becomes pale, or of leaden or yellowish hue, and the blood suffers a very complex change, the main characteristics of which are diminution in the number of red corpuscles and coincident increase of the white. Not infrequently during this stage the patient is harrassed by the development of a mild type of acute synovitis, affecting one or more joints, and terminating in early recovery.

The period of secondary incubation, like all the “periods” of syphilis, is subject to wide variations of time, but may be said to last upon the average about six weeks, the extremes reported being twelve days and six months; in fact, Keyes states that the secondary stage of syphilis may in rare cases be omitted altogether, the next manifestation after the primary lesions being development of “tertiary” syphilis several years later.

**Syphilitic Fever.**—In quite a large percentage of cases the prodromal symptoms of general syphilis are accompanied by an elevation of temperature which ranges from 100 to 104 degrees F. This fever begins

a few days before the eruption appears, usually reaches its height at the appearance of the eruption, then gradually subsides, only to recur in a milder manner at the appearance of each succeeding crop of eruption. Not every case of syphilis is attended by fever, and, as might naturally be supposed, the pustular and ulcerative lesions are characterized by a higher range and longer duration of febrile disturbance.

**Syphilis of the Skin.**—At the end of the period of secondary incubation there appears with great constancy upon the skin and some of the mucous membranes an eruption which may assume many different forms, and which is of great importance to the patient on account of its disfigurement, and to the surgeon as one of his chief guides in establishing a diagnosis. These eruptions, or “syphilides,” develop as a rule quite slowly, run a chronic course, tend to reappear in “crops,” as it were, new lesions and new forms of lesions frequently appearing before the old ones have resolved; so that it is quite the rule to find, for instance, macules, papules and pustules side by side. In the early secondary stage the eruptions are generalized and symmetrical, one side of the body being an almost exact counterpart of the other, while as the disease becomes older and the tertiary period approaches they tend toward asymmetry. The syphilides tend to develop in the form of circles and segments of circles, extending at the periphery while resolution is going on in the center. Their color varies with the particular lesion and the complexion of the patient, but is most frequently described as being of a brownish-red or coppery tint. The syphilides leave a peculiar pigmentation in the skin for a time after they have resolved, and the ulcerating lesions leave cicatrices which are at first pigmented but which gradually become white, shining and depressed. The scaling eruptions produce scales which are of a dirty-grayish color and do not glisten like the scales of psoriasis. All of the syphilitic eruptions are free from itching, as, indeed, from any subjective symptoms, as a rule, but they give rise to pain if so located that they become irritated, or to itching if they are of very rapid development. The tertiary syphilides are more deeply seated than the secondary, are localized, asymmetrical and occur without order or regularity. In a large majority of cases tertiary eruptions do not appear, but when they occur their tendency is toward a destruction of tissue which leaves permanent scars.

**MACULAR SYPHILIDE.** In the regular development of syphilis, and especially in mild cases, the first eruption to occur is an erythema which takes the form of small, round, or oval, hyperemic spots, or macules, of a pinkish-red color, which at first disappear under pressure; later they become darker and do not entirely disappear under pressure, tending rather to leave a yellowish stain. This eruption has a predilection for the chest, abdomen, neck and flexor surfaces of the limbs, rarely attacking the face. It is aggravated by a hot bath or by chilling the surface, is usually accompanied or preceded by syphilitic fever, and lasts at most only a few weeks, sometimes disappearing in ten days. In many cases this eruption is so slight as to escape notice, while in others it is very pronounced and merges into the papular form.

**PAPULAR SYPHILIDE.** Next in chronological order is the papular syphilide, the most common and most typical syphiloderm. There are several forms of this lesion which are determined largely by anatomical





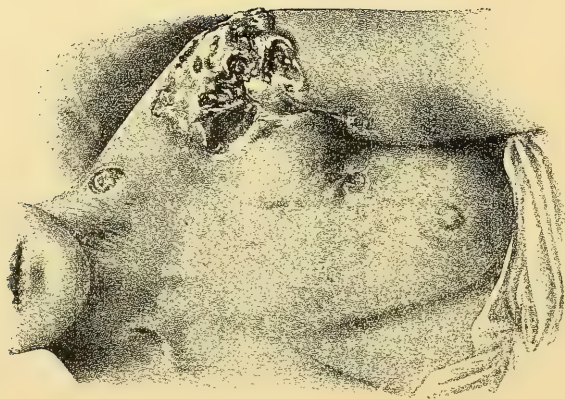


Figure 1.  
Serpiginous Gumma, Involving Deep Structures.

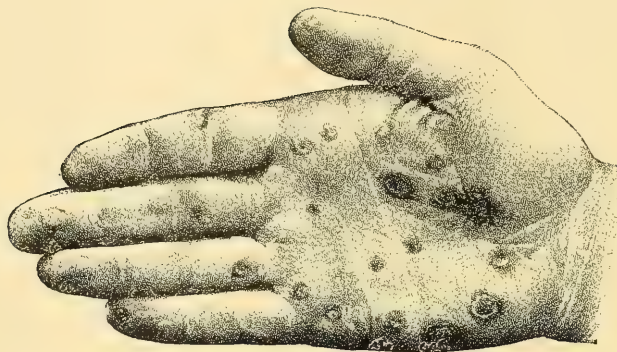


Figure 2.  
Palmar Papules.

## PLATE VI, B.—VARIETIES OF SYPHILIS.

situation and the virulence of the process. Millitary papular, lenticular papular, nummular, papulo-squamous and moist papular are terms which are more or less self-explanatory. Each of these lesions has special characteristics, a description of which should be sought in works upon skin diseases. In general it may be said of this form of syphilide that it belongs to both the secondary and tertiary periods, rarely developing earlier than the third month of syphilis and, some of its more obstinate forms still being present, in some cases years after the chancre has disappeared. It tends to recur in crops, and while typically a later lesion than the macular syphilide its early appearance is not infrequent, and is indicative of a more malignant form of disease. The typical papule is a somewhat elevated pimple, of bright-red color at first but later fading to a coppery hue. The epidermis about its summit desquamates early, while that at its base remains partially attached, giving each papule a peculiar, fringed appearance. This desquamation may be so marked that scales and even scabs form (papulo-squamous syphilide). The papules sometimes originate from pre-existing macules, and while they may be distributed more or less thickly over the whole body they have a special tendency to appear upon the forehead (*corona veneris*), face, shoulders and back. The papular syphilide usually disappears in three or four weeks under mercurial treatment, but in some cases it is very persistent and recurs through years of time. Occurring as it often does about the natural orifices and upon the delicate skin of the scrotum, labia, axillæ and in the folds beneath the mammary glands in women the papule undergoes a modification in the loss of its epidermis, becoming broad and flat in shape, when it is styled a mucous plaque of the skin or moist papular syphilide. In some cases these lesions become the seat of a hyperplasia of the papillary layer of the skin, producing a broad, low elevation, in which condition they are designated condylomata, and as they are quite common about the anus, vulva, scrotum and folds of the skin in this vicinity they are frequent sources of contagion.

When the papular syphilide is located upon the palms and soles it undergoes peculiar modifications due to the thickness of the overlying epidermis, and firm, close attachment of the skin to the sub-cutaneous tissues. The papules are scarcely elevated and appear as dull red spots which tend to increase toward the periphery. They begin near the center of the palm or sole, and as they spread often coalesce, forming circular or crescentic patches which heal in the center while they spread at the periphery by the development of new papules. The epidermis is gradually detached, leaving dirty-whitish fringes of partially exfoliated epidermis, and cracks and fissures are likely to occur in the furrows and creases and become very painful. These lesions are especially important from their diagnostic value, since they are exceedingly persistent and may remain as unmistakable "tell-tales" after all other skin lesions have disappeared. They resemble only two other diseases, psoriasis and eczema. Psoriasis occurring upon these locations is almost always attended with lesions of a typical character in other localities. Eczema most frequently begins upon the wrist or at the root of the finger, and frequently extends to the back of the hand, which rarely or never occurs in syphilis. Eczema is attended with itching, and its lesions have at some time in their existence been moist, which is not the case with syphilis. Palmar and plantar



syphilides are exceedingly stubborn to anti-syphilitic treatment, and may, in spite of the best efforts, persist for years.

**PUSTULAR SYPHILIDE.** Theoretically the formation of pus is not a part of the syphilitic process, and in considering the pus-forming syphilitic lesions it should be borne in mind that there is still some dispute as to their mode of origin. The author's view of the matter is that the development of purulent eruptions is always dependent upon either a general or local septic infection. That papules upon some patients tend to become pustules should be taken as evidence that the patient is the subject of two processes, the syphilitic and the suppurative. This is further strengthened by the clinical facts that pustular lesions do not respond readily to anti-syphilitic treatment and that they occur most frequently in depraved subjects. Whatever may be the factors in its causation pustular syphilide resembles very closely the papular variety with the addition of the pus-forming element. It appears in various forms and its chronological period is very variable. It may appear early in the form of papules, which become surmounted by vesicles (vesicular syphilide), which in turn become pustules and quickly resolve, leaving a small crust followed by scales, then a brownish spot, which disappears without a cicatrix. On the other hand, the process of suppuration may involve the whole papule and extend to the skin beneath, forming an ulcer which tends to extend and leave a permanent scar, this latter type being often one of the characteristics of malignant precocious syphilis. The varicella-form syphilide, from its resemblance to varicella; the variola-form, from its resemblance to variola; the acne-form syphilide, from its resemblance to acne vulgaris; the impetigo-form syphilide, from its resemblance to impetigo; ecthyma-form syphilide, from its resemblance to ecthyma, and the rupial syphilide are all pustular lesions which occupy a somewhat uncertain chronological position, the more superficial ones which tend toward early resolution being usually considered as secondary lesions, while the deeper, destructive, scar-forming types are doubtless tertiary, although the exact point of transition cannot be determined.

**VARICELLA-FORM SYPHILIDE.** This somewhat resembles, as its name implies, varicella. The pustules begin as papules, become vesicles, then pustules, being perhaps the size of a small pea and surrounded by a dull red areola. Later they umbilicate and ultimate evaporation of the fluid results in the formation of a crust which, upon falling, leaves a brownish stain. This form of eruption often makes its appearance early and sometimes may have characteristics which, when taken in conjunction with an accompanying syphilitic fever, have led to its being mistaken for smallpox. Its favorite locations are the forehead, sides of the trunk and flexor surfaces of the extremities.

**ACNE-FORM SYPHILIDE.** This form, resembling acne vulgaris, is another early and superficial form which appears in crops upon the face, scalp, shoulders, trunk and thighs.

**IMPETIGO-FORM SYPHILIDE.** It usually affects the face, scalp and forehead and is characterized by pustules which are short-lived, but leave a crust under which a superficial ulceration goes on, tending to re-accumulate if detached. When resolution takes place there remains a pigmented, superficial scar which ultimately becomes white.

**ECTHYMA-FORM SYPHILIDE.** This form is most frequently found upon the lower extremities, although the arms may be involved. It results in the formation of greenish or brown crusts which rest, and sometimes almost float, upon an ulcerating surface. This lesion is a late one (often classed as tertiary) except in those cases of malignant precocious syphilis in which its early presence gives warning of the severe nature of the case. The cicatrices which remain are more or less circular, white and depressed.

**RUPIAL SYPHILIDE.** This is said to be the most typical of all the syphilitic eruptions. Its main characteristic is the peculiar, conical, stratified crust, the apical layer of which represents the original size of the lesion. As the underlying ulcer slowly increases in size it deposits layers of gradually increasing diameter on the bottom of the crust and this process is repeated until the thick, conical crust falls, marking the beginning of resolution. *Rupia* is a late secondary or early tertiary lesion.

**TUBERCULAR SYPHILIDE.** Midway between the papule of secondary syphilis and the gumma so characteristic of the tertiary stage stand the two forms of tubercular syphilide. Nevertheless this is a tertiary lesion and its date of appearance, except as a precocious eruption, is from the third to the twentieth year after the initial sore. Like all tertiary lesions it is likely to be asymmetrical, sometimes isolated or even disseminated, but more often grouped in patches which may occupy any portion of the cutaneous surface, although they have a predilection for the face, neck, back and legs. The form "dry" or "ulcerating" is determined by the method of disappearance of the infiltration, those tubercles which disappear by resorption being characterized as dry, those which ulcerate as ulcerating. Syphilitic tubercles may be described as mild gummata which are confined to the skin itself. They appear as small tumors of a yellowish-red color, the dry form being covered by rather thick scales or crusts whose resolution, even when it occurs without ulceration, leaves a pigmented cicatrix. The ulcerating variety is one of the most common and important tertiary lesions, since, according to Julien, it makes up fully one-fourth of the tertiary lesions which we meet. Its chronological period, is, as a rule, somewhat later than that of the dry form, although it may appear in grave cases as a precocious syphilide. The early history of tubercle is the same as that of the dry form, but in its later stages softening begins in its center and results in the formation of a more or less deep, abrupt, angry ulcer which discharges grayish-yellow matter. Great destruction of tissue may, and often does, take place through extension of the infiltration by formation of new tubercles upon the periphery, while ulceration follows in their wake at the same time that healing occurs in the center. In this manner a large portion of the nose or face may be destroyed within a few weeks. From its frequent location upon the face and about the nose, the formation of peculiar crusts, the central cicatrization and simultaneous peripheral induration and ulceration, the differential diagnosis between it and lupus vulgaris is by no means easy. The following diagnostic table is made up from symptoms recorded by various authors:

*Tubercular Syphilide.*

Usually occurs in adult life.  
Often begins in deep structures, even bone.  
Skin infiltrated.  
Copper-colored areola sharply defined.  
Tubercles opaque and of a deep brownish-red color.  
Course quite rapid—to be measured by weeks or months.  
Ulcers discrete, circular, deep, edges sharply cut, indurated and undermined.  
Painful under pressure.  
Secretion copious, offensive.  
Ozena, often.  
Crusts thick and of characteristic greenish-black color.  
Cicatrices, thin, soft, white, circular, depressed.  
History of other syphilitic lesions.  
Responds to constitutional treatment only.  
Tubercle bacilli absent.

*Lupus Vulgaris.*

Usually begins in youth.  
Begins superficially and extends to deeper structures—never attacks the bone, however.  
Not so marked.  
Inflammatory areola fading into healthy skin.  
Tubercles pinkish, translucent, described as being of "apple jelly" color.  
Course chronic—to be measured by months or years.  
Ulcers often confluent, irregular, superficial, edges softer, bleed easily.  
Painless as a rule.  
Secretion slight, odorless.  
Ozena, none.  
Crusts thinner, color dark.  
Cicatrices thick, distorted, puckered, irregular.  
No such history.  
Responds to active local treatment.  
Tubercle bacilli often present in small numbers.

**GUMMATOUS SYPHILIDE.** This is distinctly a tertiary lesion beginning in the sub-cutaneous tissue and even deeper structures but, later in its history, involving also the skin. Gummata, unless precocious, develop from three to thirty or even forty years after the initial lesion—often after all other evidences of syphilis have disappeared and even after the patient has forgotten the indiscretion of youth and its attendant "troubles." At first the gumma appears beneath the skin or mucous membrane as a solid movable tumor varying in size from a pea to two or three inches in diameter. The overlying skin is movable and of a yellowish color. As the gummata develop the skin becomes more involved, of a darker color and less freely movable. From this period one of two courses may be pursued: First, in exceptional cases resorption may take place without the occurrence of ulceration; or, secondly, softening may begin in the center, when the skin gradually becomes inflamed, dark red and thin, giving the central portion of the mass a feel which is often and easily mistaken for an indication of the presence of pus. Ultimately perforation with the discharge of a viscid fluid takes place, leaving a deep, more or less circular ulcer the surface of which is covered with shreds of broken-down tissue, while its edges are hard, infiltrated and often undermined. Gradually these shreds or necrotic tissue become exfoliated, leaving a healthy granulating surface which, filling up the excavation more or less



completely, leaves a somewhat depressed, circular, white scar. The gumma runs an exceedingly chronic course and the ulcers resulting therefrom are subject to such accidents as inflammation, gangrene and phagedena. Upon the middle and upper third of the leg as well as about the ankles these ulcers are often mistaken for varicose ulcers and treated as such.

**Syphilitic Alopecia.**—Loss of the hair from any portion of the body may be one of the symptoms of syphilis. It most frequently occurs upon the scalp and eye-brows, rarely the beard. There are two forms of the affection, one being primary and the other consecutive to other syphilitic lesions of the hairy parts. The pathology of primary syphilitic alopecia is but little understood. The condition probably depends upon malnutrition of the hair follicles, resulting in the death and falling off of the hair. The consecutive form may accompany any of the syphiloderms which affect the hairy surfaces. Both varieties occur in the early secondary stage and the prognosis for return of a growth of hair is invariably favorable except in those cases where ulcerative lesions have destroyed portions of the integument.

**Syphilitic Onychia.**—This, like the first form of alopecia, is a non-inflammatory affection due so far as we know, to the effect of the syphilitic dyscrasia upon the nutrition of the nail. In some cases the only manifestation is a peculiar loss of lustre and breaking of the nail along the edge, in others there occurs a separation of the nail from the nail bed or from the matrix, resulting in complete detachment with the ultimate reproduction of a new nail. In still other cases an hypertrophy of the nail occurs, together with yellowish discoloration and longitudinal striation. All these varieties of onychia are secondary manifestations, all are attended by loss of lustre, longitudinal striation, and all are followed by reproduction of a healthy nail.

**Syphilitic Paronychia.**—This bears about the same relation to onychia that the second form of alopecia does to the first, i.e., it is an inflammatory affection of the soft parts about the nail and affects the nail itself only secondarily.

**DRY PARONYCHIA** begins at the corner of the nail as a non-inflammatory, rather hard lump like a corn, and may extend around the whole nail. The epidermis becomes thickened and is exfoliated or torn off, frequently leaving very painful cracks and fissures.

**INFLAMMATORY PARONYCHIA** resembles the dry variety in its inception but is characterized by inflammation, without, however, the formation of pus, except in rare instances. As a whole it resembles "run-around" except that it is very chronic in its course. The most severe form is known as ulcerative paronychia, and is characterized by a very chronic and severe form of ulceration which involves the whole circumference of the nail and its bed, the formation of large unhealthy granulations and the ultimate exfoliation of the nail with reproduction of a deformed nail in some cases and destruction of the matrix in others.

## CHAPTER XXVI.

### CONSTITUTIONAL SYPHILIS—Continued.

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**Syphilis of the Mucous Membranes.**—The location and functions of the various mucous tracts exercise quite an influence upon the manifestations of syphilis in the different mucous cavities and canals, nevertheless they possess a similarity which admits of a single description. Primary syphilis of these regions has been considered in the early part of this article; secondary syphilis has a tendency to manifest itself upon the mucous membranes, which is second only to its tendency toward skin lesions. The earliest appearance of syphilis which we observe upon the mucous membrane is likely to be a more or less diffuse erythema, which is coincident with the roseola or macular syphilide, and which is most often seen upon the soft palate and in its immediate neighborhood. Its most characteristic feature is the sharply defined border, by which one may frequently distinguish it from a simple catarrhal inflammation; however, it rarely presents such characteristics as to warrant a positive diagnosis in the absence of other symptoms. The more usual accompaniment of the secondary skin eruptions is the mucous patch or mucous plaque, which most frequently takes its origin from a papule, and may originate *de novo* or from an initial lesion. Mucous patches may occur singly, but are more often multiple, and may appear upon any mucous surface, although they have a special tendency to develop about the corners of the mouth, near the gingivo-labial fold, along the borders of the tongue, upon the faucial pillars, and, in fact, at any point of irritation, whether it be that from a sharp tooth, pipe, cigar or what not. Very frequently they are symmetrically arranged, or one upon the tongue has its mate upon the cheek. The first evidence of the plaque is a red spot, which may be elevated or not, but which loses its epithelium within a few hours, becoming a red, inflamed surface. It is round or oval in shape, and usually becomes covered with a grayish deposit, giving an appearance as though the surface had been brushed over with a strong solution of nitrate of silver. It is in this stage that the term “plaques opalines” is applied by the French. This opaline coating consists of a fibrinous exudate in which many epithelial cells are entangled, and is not always present, since mucous patches often disappear before they have progressed so far.

It quite frequently happens that this pellicle becomes forcibly detached in some manner, leaving a red, eroded surface, which again becomes coated over or may become the seat of hypertrophic or superficial ulcerative changes, resulting in various modifications and presenting clinical pictures widely different. There can be no doubt that irritation from any cause whatever acts as an exciting cause of mucous patches in syphilitics. A tooth with a sharp corner and edge, or teeth which are the harbingers of septic or irritating material are most fruitful sources of local irritation, and serve to originate and continue these lesions during the acute period of syphilis. Tobacco in one form or another is the most frequent irritant





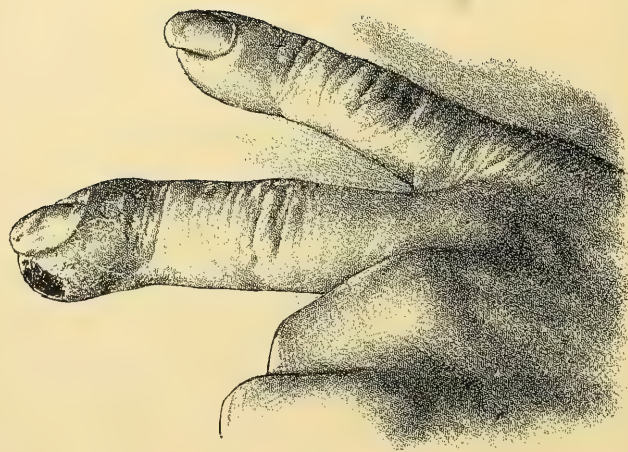


Figure 1. Ulcerating Initial Lesion of Ring Finger.

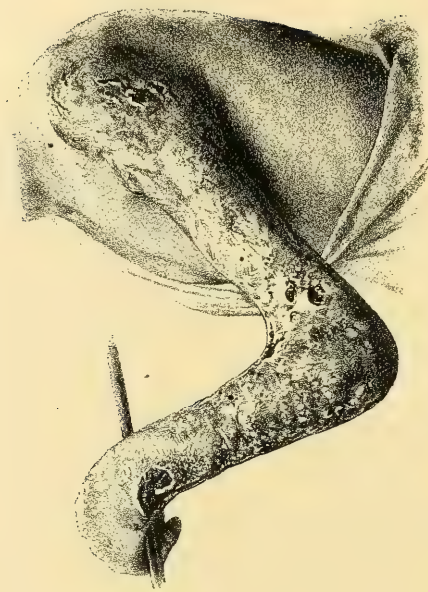


Figure 2. Gummatous Ulceration of Arm with Ankylosis of Elbow.

## PLATE VII.—VARIETIES OF SYPHILIS.

of the buccal mucous membrane, and we are therefore almost sure to find patches in the mouths of syphilitics who smoke. While the lesions often disappear of themselves, and are almost always quickly cured by proper treatment, they tend to recur, and this process may be almost indefinitely prolonged by smoking. When mucous patches are located upon parts subject to frequent motion and strain, as the corners of the mouth, center of the tongue, etc., and the tissues forming their base become thickened, they often become the seats of cracks and fissures which are exceedingly painful and bleed easily. Other forms of mucous patches are characterized by a peculiar "shaven" appearance of the lingual or buccal mucous membrane and by marked thickening. These lesions are essentially later and more refractory than the moist plaques and are classed as scaly forms.

Mucous patches rarely develop within the nasal fossæ, and we know nothing of their presence in the esophagus, stomach, small or large intestines, or within the rectum. At the anus, however, they are of very frequent occurrence and have characteristics similar to the lesion found in the mouth, the few differences which exist depending upon variations of surrounding tissue and the additional tendency toward ulceration which leaves ragged margins. Mucous patches occur within the urethra and give rise to a contagious discharge; they call for no especial notice at this time. The vagina is quite exempt from them, although the cervix uteri is frequently involved. Conjunctival mucous patches are not materially different from those found in the mouth.

SECONDARY ULCERS sometimes develop upon the mucous membranes, especially in the mouth and throat. These ulcers differ from the later or tertiary ulcers in that they do not spring from gummata, and are not as deep and destructive in their tendencies. They are of circular or elliptical shape and have a yellowish base dotted with granulations. Ulcers which are attributed to the late secondary period also occur in the rectum, but it appears that this condition is somewhat misty in the minds of rectal surgeons as well as syphilographers. Kelsey gives a fairly good account of them. In the larynx and trachea secondary ulcers of large extent sometimes fall under the laryngologist's eye, although it is believed that the more frequent lesions in this region are of a tertiary nature and arise from degenerating gummata.

**Syphilis of Joints.**—Early in the secondary period or during the second period of incubation we meet the mild forms of synovitis which have already been referred to and which call for no special consideration here. There are however lesions of the various tissues of the joints which belong to the tertiary period and are of importance. First, there develops a peculiar thickening of the synovial membrane, especially about its various reflections, and these project into the joint cavity; at the same time there may be present sub-synovial gummata or small gummata located within the cartilages. Attending the development of these conditions there is an increase in the synovial fluid (hydrops articuli) and some pain which is worse at night. The functions of the joints are not as much interfered with as in tuberculosis. If a gumma breaks down and discharges into the joint cavity, or both into the joint and externally, suppuration may occur, although it is not usual. As the syphilitic new-growths progress the hydrops increases, and ultimately general synovial thickening limits the motions of the joints, producing partial or complete

fibrous ankylosis. If sub-chondral gummata resolve they are replaced by cicatricial tissue which in contracting depresses the surface of the cartilage, leaving characteristic "defects of the cartilage," these remaining as depressed surfaces surrounded by fringe-like tufts.

**Syphilis of Muscles.**—Though rare, this occurs and in two distinct forms; a peculiar form of atrophy or contracture which affects the long muscles of the extremities, most frequently the biceps, and as gummata located within the substance of the muscle. The first form comes on from three months to two years, or even more, after the initial lesion and begins by stiffness and nocturnal pain accompanied by a gradual shortening of the muscle. Gummatus myositis, a tertiary lesion, is dependent upon the development of gummata within the body of the muscle. These gummata sometimes resolve without disintegration, when they simply leave a scar within the muscle; more often, however, they extend to surrounding tissues, break down and discharge through the skin, leaving an ulcerated tract and a scar which binds together all the tissues involved.

**Syphilis of Bones and Periosteum.**—Even as early as during the primary stage of syphilis affections of the bones have been reported. Such cases, however, are very rare and must be the subject of some doubt. During secondary syphilis bone or periosteal lesions are not frequent, and may be considered precocious lesions. Osseous and periosteal syphilis may, as a rule, be classed as tertiary and is usually dependent upon gummatus inflammation. Certain bones, as the tibia, radius, ulna, clavicle, bones of the cranium, nose and the sternum, show a marked predisposition to the development of syphilitic lesions, and these lesions are doubtless dependent in a majority of instances upon traumatism as an exciting cause. When the periosteum is the original seat of disease there occurs a local gummatus inflammation and swelling commonly called a "periosteal node," which is exceedingly painful, especially at night, and is sensitive to pressure. These nodes are particularly liable to mixed infection and suppuration. If they become extensive, as they often do, upon the skull and tibia, the nutrition of the underlying bone is interfered with and necrosis occurs. Perforation of the cranial bones is a possible occurrence. In the author's service at the Laura Franklin Hospital a child with hereditary syphilis developed a gummatus periostitis in the frontal region, which suppurated and laid bare three-fifths of the sub-cutaneous portion of the frontal bone; in this case the right tibia was affected by an osteitis and the patient ultimately succumbed to nephritis. Where both periosteum and the bone are involved the lesion is known as an osteo-periostitis. In the bone itself gummata frequently develop and are attended by pain, which is worse at night, and by tenderness upon pressure. These bone pains (osteocopic pains) are very characteristic, and their aggravation at night is a symptom which should always put the surgeon on guard to establish a diagnosis. As the gumma develops the bony trabeculae become absorbed, or, if the circulation is sufficiently interfered with, necrosis and the formation of sequestra occur. Suppuration is a frequent complication and sinuses often form and continue until the necrosed bone is exfoliated or removed, or until the process is arrested by anti-syphilitic remedies. As this "rarefying osteitis" subsides there begins a "formative osteitis" which results in partial or complete reconstruction of the lost tissue, or in the formation of a superabundance of bone tissue which may



result in permanent deformity, or in some cases in the formation of new tissue about a sequestrum, which is entrapped, as it were, and may cause trouble until it is removed. This same process of formative osteitis also occurs independently of the rarefying osteitis and often produces "osteophytes" or larger "nodes" or "exostoses," "endostoses" or "hyperostoses."

**Syphilis of the Fingers and Toes.**—Closely allied to syphilitic osteitis and periostitis are two forms of the disease which attack the fingers or toes in the late secondary or, more infrequently, the tertiary stage. The first form is a diffuse gummatous formation which takes place in the soft parts beneath the skin, and results in a fusiform swelling which may involve one or two phalanges or the whole member. Pain is by no means a prominent symptom, nor is tenderness. The skin is involved in a secondary manner only. The process is chronic in course, and suppuration is not the usual result although it may occur from mixed infection. The second form of dactylitis takes its origin from the bone or periosteum, and the pathological process does not differ from that of syphilitic osteitis and periostitis in other parts of the body. The process in this form of dactylitis is somewhat more acute than when the soft parts only are involved. It occurs both in hereditary and acquired disease, and usually begins in the shaft of the bone, although the joints may become involved later. If ulceration occurs a good deal of deformity and impairment of function may result from ankylosis, pseudo-arthritis, and loss of substance with arrest of growth.

It is important to distinguish syphilitic dactylitis from spina ventosa, or tubercular dactylitis which resembles it very closely in some cases. The tuberculous affection is often accompanied by other tubercular lesions and there is likely to be present a history of tuberculosis, while syphilitic history and other syphilitic lesions are absent. The tubercular affection begins in the cancellous structure of the bones, usually in the articular ends; it sometimes originates in the synovial membrane but never begins in the soft tissues or periosteum; pain is not usually a marked symptom, while in syphilis pain is present, and is usually worse at night.

**Syphilis of the Vascular System.**—The heart is the seat of tertiary syphilitic lesions only. It is comparatively rarely affected, and its lesions are either gummata or some of the various forms of inflammation the relations of which to syphilis are more or less in doubt. The arteries are not affected so far as we know by secondary syphilis, but tertiary lesions are said to be common and to take the form of arterio-sclerosis, endarteritis, gummatous peri-arteritis, hyaline and amyloid degeneration. The relation of syphilis to many of these conditions, which are also produced by other diseases, is doubtful. The symptoms are not usually sufficiently characteristic to warrant a diagnosis except when the arteries of the brain are involved, and, therefore, the practical points will be considered under syphilis of the nervous system.

**Syphilis of the Genito-Urinary System.**—Primary and secondary syphilis as it appears upon the male and female external genital organs has incidentally been described when describing the various forms of chancre and syphiloderma. Not infrequently there occur late ulcerative lesions of the sheath of the penis which demand great care in diagnosis in order not to confound them with chancreoid. These ulcerations

frequently present in themselves no differential points from phagadenic chancroidal ulcerations, and, therefore, we are obliged to look to the patient's history and the effect of treatment for our diagnosis. The chancroidal ulceration is painful as a rule, syphilis has but slight pain or is painless; phagadema in chancroids is usually associated with marked deterioration in general health, in syphilis it may manifest itself suddenly in an otherwise apparently healthy syphilitic. In chancroid there is usually a history of recent suspicious contact, while in syphilis this may be absent and a syphilitic history may be elicited. Anti-syphilitic treatment gives no result in chancroid, while caustics only make matters worse when applied to syphilitic ulcerations in this locality.

**Syphilis of the Testicle and Epididymis.**—The epididymis is most likely to become affected by syphilis during the secondary period, while syphilis of the testicle is almost invariably tertiary. Syphilitic epididymitis may involve both sides or only one. It involves the head of the epididymis in a hard, distinct tumor which does not project over the testicle, and which gives rise to very little if any pain. This tumor varies from the size of a pea to that of a hazel-nut, or larger. Hydrocele of rapid development is a frequent accompaniment.

The testicle proper is a rather frequent location for tertiary manifestations where they commonly appear under two distinct forms: First, Diffuse Interstitial Inflammation; second, Gummata.

**DIFFUSE INTERSTITIAL ORCHITIS.** This is a peculiar chronic inflammation of the fibrous septa of the organ, in which they become much thickened by the development of new fibres, thus exerting great pressure upon the secreting substance. This pressure is further increased when the newly-formed fibres contract, as they ultimately do, and a frequent termination of the process is atrophy of the whole organ or that portion of it which was involved in the disease. Pain and tenderness are not prominent features of this process, and hydrocele, while possible, is rarely present.

**GUMMATOUS ORCHITIS.** This is a comparatively painless affection which results in the development of one or many nodules in the testicle. These nodules pursue the usual course of gummata elsewhere in the body. As they increase in size softening begins in the center, the superstructures, including the skin, become adherent, soften, ulcerate and allow the fungous-like material to extrude, carrying with it portions of the tubular structure of the testicle. These fungi are rather firm to the feel, painless and do not bleed easily. The whole process is characterized by painlessness, abolishment of the testicular sensation and chronicity.

**Syphilis of the Vulva.**—No further reference will be made to primary and secondary lesions about the vulva, as they have received sufficient consideration in the early part of this section, but note must be made of some of the more frequent lesions which occur later in this region and are somewhat unique. One of the most frequent of these is a local thickening and induration of the tissue making up the labia majora, mons veneris, and sometimes extending to the perineum. Edema and hyperplasia are occasionally added conditions, due to irritation by discharges and friction. Extensive ulceration also occurs either in conjunction with the above process or independently of it. These ulcer-



ative lesions are easily confounded with chancroid, simple ulceration, malignant growths and tubercular ulceration. The differential diagnosis in these cases must rest largely upon the history of the patient and the effect of treatment. Tubercular ulceration is exceedingly rare upon the vulva, except when secondary to uterine tuberculosis, and lupus is said never to occur in this region.

**Syphilis of the Placenta.**—This has not been the subject of as much painstaking investigation as it deserves and, therefore, there is little to be said upon it. The frequency of miscarriage and premature delivery among syphilitic women is a clinical fact well known by all practitioners, and it appears that the specific lesion causing this premature termination of pregnancy is in the placenta. Frankel's investigations are quoted: (a) There is a syphilitic disease of the placenta with characteristic lesions. (b) The placental syphilis is found only with congenital syphilis of the fetus. (c) The seat of the disease is different according to whether the mother is healthy, syphilis being conveyed by the father, or whether the mother also is diseased. In the first case the placenta also is affected along with the fetus; the affection consisting in the definite growth of cellular granulation tissue, with resulting obliteration and destruction of the vessels of the villi, often complicated by a marked thickening of the epithelium. (d) In the second case, when the mother is syphilitic, there are other possibilities. In the first case the mother is affected in conception along with the fetus; there is then syphilitic disease of the fetal portion of the placenta, often with involvement of the maternal portion. Or, in case the mother is affected later, then the placenta can either remain normal or become affected, and when affected the affection takes the form of gummatous placental endometritis; when the infection of the mother takes place after the seventh month of pregnancy there is usually immunity of both the fetus and the placenta.

**Syphilis of the Kidneys.**—While syphilitic nephritis is probably quite common its pathology is still somewhat unfamiliar. During the exanthematous stage there occurs a more or less acute nephritis which resembles in many respects scarlatinal nephritis. It is said to occur in about four per cent. of cases and is characterized by the sudden appearance of edema of the face, scrotum, legs, or even lungs. Other subjective symptoms are usually wanting, although the patient may complain of headache and frequent, scanty urination. The urine is scanty, high colored and contains blood, albumin, casts and renal epithelia during the height of the attack, while as the edema disappears the urine increases in quantity and improves in quality. Resolution is the usual result, although chronic nephritis has been known to supervene.

Tertiary syphilis of the kidney manifests itself in comparatively few cases of the acquired disease, but much more frequently in the hereditary form. A number of pathological processes seem to combine in late lesions, i. e., amyloid degeneration, chronic interstitial nephritis and gummatous formation. The process may be unilateral, or, more frequently, bilateral. Positive diagnosis is exceedingly difficult and the prognosis grave, although not necessarily hopeless.

**Syphilis of the Eye.**—Syphilis affects all the different structures making up the eye-ball and its surroundings. Works upon ophthalmology



take up the various lesions in a most thorough manner. Inflammation of the cornea—keratitis—is not as frequent a result of acquired syphilis as of the hereditary form. It sometimes occurs as a later manifestation.

**IRITIS.** This is by far the most common manifestation of specific disease in the eye and occurs in three forms, viz., plastic, serous and gummatous. Iritis is usually an early lesion, occurring during the primary and secondary stages, although it may occur later, and only one form, the gummatous, is peculiar to syphilis. Plastic iritis dependent upon syphilis has symptoms which are identical with those observed when the lesion is due to non-specific causes, i. e., deep ciliary injection, swelling and sluggishness of the iris, contracted pupil, intolerance of light, and pain. The serous form resembles plastic iritis except that it has a slightly dilated pupil, is more chronic in its course, and is apt to be accompanied by symptoms of glaucoma and a slight deposit on the lower half of the posterior surface of the cornea. Gummatous iritis is characterized by the symptoms of plastic iritis plus the presence of papillary growths upon the iris. These growths are really gummata. It is very important in all forms of syphilitic iritis that the local measures advised in idiopathic plastic iritis be carried out to the letter, i. e., the instillation of atropia and application of heat to the eye.

**SYPHILITIC CHOROIDITIS** is not as frequent as iritis but is more chronic in its course and dangerous in its results. Its main symptoms are opacity of the vitreous humor, resulting in sudden diminution of vision, either diminution or increase of intra-ocular tension; and in those cases in which the anterior portion of the choroid is involved pain is a prominent symptom. In very severe cases the eye may be destroyed, and not infrequently vision is more or less permanently impaired. Local treatment is of great importance here also, and consists chiefly in the instillation of atropia in all cases except those in which the intra-ocular tension is increased.

**PARALYSIS.** Paralysis of some of the ocular muscles is not infrequently an evidence of syphilis and may be due to a variety of causes, e. g., gummata involving the point of origin of the affected muscle, gummatous infiltration of the meninges at the base of the brain—so located as to involve by pressure or otherwise the third, fourth or sixth nerves—or, more rarely, syphilitic endarteritis of the cerebral vessels. Bull says: "The question of the orbital, meningeal, or cerebral location of the lesion is still very uncertain. If the existing paralyses are symmetrical the lesion is probably not in the orbit. Intense headaches, with complete paralysis of one or more nerves, as well as equal paresis of all branches of the third nerve, or bilateral muscular disease with complications on the side of the optic nerve and trifacial nerve, point to the existence of a meningeal lesion so long as there are no symptoms indicating the existence of foci of cerebral disease. We may also assume the presence of a central lesion when the paralysis is complete in extent and intensity and remains unilateral and single."

**Cerebral Syphilis.**—This is as yet involved in so much doubt that it is difficult to even establish the limits of the subject. Combining the views of various authors it is easy to be led to assign syphilis as an etiological factor in a very large proportion of all nervous diseases and disturbances, yet it is a fact that actual demonstration of the syphilitic nature of only

a few conditions has as yet taken place. However as this whole subject belongs more to the realm of the neurologist than the surgeon it will be well to leave to works upon neurology and general medicine the task of discussing all doubtful points, and limit consideration to what appear to be the settled facts of the case. Keyes, basing his division upon the points of origin of the lesion, describes four varieties: First, Lesions of the bony envelopes. Second, Lesions of the enveloping membranes. Third, Lesions of the substance of the brain and cord. Fourth, Lesions of the cerebral arteries.

From a pathological point of view this division is both valuable and practical and should not be lost sight of. As there are few or no characteristic symptoms which distinguish some of these classes of lesions, the author prefers to follow a more general method in describing the course of brain syphilis. It may be said that brain lesions are always tertiary in their nature, rarely appearing earlier than one year after the initial lesion and more often as late as ten, fifteen or twenty years. It is frequently the case that the subject of cerebral syphilis has forgotten the early symptoms of his disease both on account of their remoteness in time and their mild character. There are, however, cases in which death has resulted from involvement of the brain within a few months of the initial lesion. It is impossible to predict what patients will develop cerebral lesions, but it is generally conceded that the inherited tendency to nervous disease, mental strain, traumatism, and, above all, neglect of treatment in the early stages predispose to this form of the malady.

The pathological changes which take place may be summed up in the words "syphilitic new growth," and variation in the location and distribution of this new growth gives a variety of clinical pictures which has led to the statement that there is no symptom of nervous disease either structural or functional in character that may not be simulated by syphilis. Frequently the new growth takes the form of gumma, is localized in one or more spots, either in connection with the bony envelopes of the brain or the meninges, or, more rarely their location is in the brain itself. What has been said of the histological character of the gummata in general and of the changes which the tissue is prone to undergo may be applied to gummata in connection with the brain or meninges. They may be strictly localized or somewhat diffuse, involving quite a large surface. They may undergo cheesy degeneration, beginning in their center and gradually extending, or, on the other hand, may become transformed into fibrous tissue and result in large cicatrices.

In other cases, and they form a large class, the same kind of new growth takes place in the arteries, especially those at the base of the brain. This process is by no means confined to the brain but is to be found in the vessels of various localities. It begins in the intima and closely resembles ordinary granulation tissue, consisting of small round and spindle-shaped cells. This new tissue forms an imperfectly fibrillated structure, the adventitia becomes abnormally vascular and infiltrated with round cells, pronounced diminution in the lumen of the vessel takes place, and, finally, in many cases sudden thrombosis completely shuts off the circulation in a portion of the brain.

Those cases in which gummata develop partake, in their clinical symptoms, of the characteristics of cerebral tumors in general, with the

presence sometimes of features which render their syphilitic nature apparent. If the growth is at the base of the brain the cranial nerves are likely to be affected; especially is there likely to be paralysis of the motor oculi and such disturbances as unilateral choked disc or hemiopia. If the trigeminus is involved or pressed upon disturbances of sensation in the face result. Facial paralysis may be present. When the growth is near or upon the cortex convulsions of an epileptiform character are likely to occur, paresis of one limb may be present, and disturbances of speech and mental impairment are not infrequent. These cases may terminate quickly—convulsions increasing in frequency and severity and being followed by coma and death.

In those cases in which endarteritis is the prominent lesion such pronounced symptoms as marked headache with nocturnal aggravation and perhaps spells of weakness, dizziness, tingling or numbness of members of the side which is to become affected are followed by more or less sudden hemiplegia. The shock may be pronounced or only slight. It may be followed by mental confusion and dullness or even by coma. These patients sometimes die quickly, their shock being followed by a high fever, or on the other hand their recovery may be slow and interrupted by recurrences.

Still another class of brain lesions—probably those in which the smaller vessels are affected—leads to a condition analogous to, if not identical with, general paralysis of the insane.

As has been intimated there is little in the symptoms enumerated which would stamp any particular case as being syphilitic in origin; therefore, it is wise to bear in mind some few concomitant conditions which will frequently lead to a correct diagnosis where a mere observation of the nervous symptoms might mislead or leave us in doubt. The most valuable guide in establishing the diagnosis of syphilitic disease of the brain is the presence of a definite history of syphilis. Failing this we must look for physical evidence of present or former syphilitic lesions; characteristic scars upon the skin or mucous membranes, ulcers, adenopathy, exostoses, periosteal nodes, shrunken testicles, evidences of previous attacks of keratitis or iritis, etc., will often be deciding factors. The age of the patient is exceedingly important as it is admitted that "80 per cent. of all organic diseases of the nervous system occurring prior to the fiftieth year of life are syphilitic in origin, provided other ordinary causes of organic nervous disease in young adults can be excluded." Other evidence being insufficient, the efficacy of anti-syphilitic treatment will sometimes lead to a decision.







Figure 1.  
Circular Ulcer of Tongue.

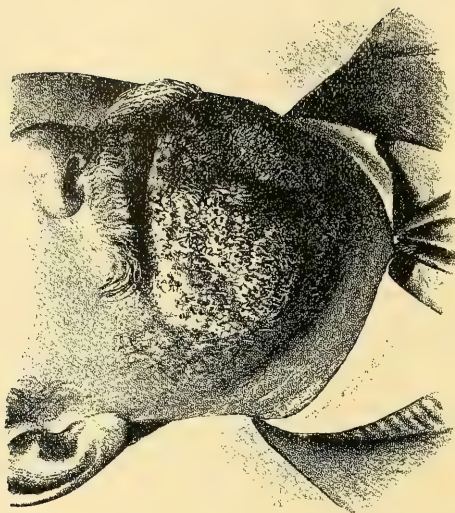


Figure 2.  
Dermatomycosis Sycotica.

## PLATE VII, A.—VARIETIES OF SYPHILIS.

## CHAPTER XXVII.

### HEREDITARY SYPHILIS.

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Consideration of this subject takes us at once into one of the most interesting and important phases of disease, yet one in which there exist more doubt and variance of opinion than would at first appear from the unqualified and positive statements made by many authors. For at least three hundred and fifty years the conditions of hereditary transmission of syphilis have been the subject of painstaking and exhaustive study and observation, and yet, important as are the questions involved, there is nothing like an unanimity of opinion. It is true that as physicians nine-tenths of us hold, advocate and teach certain theories in this relation. A large percentage of us when asked by a patient whether or not the disease would be transmissible under such and such given conditions would give the same answer. However, we know this counts for very little in a scientific way, for few physicians are endowed with those qualities and surrounded by those circumstances which permit them to draw conclusions of their own, based upon pure observation of nature and uninfluenced by the dictum of this or that "authority." This is by no means intended as an uncharitable criticism but rather as a statement of fact which will, it is hope, remind the surgeon that the "generally accepted view," held by the "majority of the profession" may be practically a quotation based upon very meagre observation of facts, and is often far less correct than the view held by some few observers who, while they may have been careful students of nature, have, perhaps, not possessed those qualities which lead them to enforce an impartial hearing and general acceptance of their views.

One of the greatest terrors which syphilis possesses for the young man is the knowledge that not only has he to suffer the ravages (if they may be dignified with so resounding a title) of the disease, but, more than this, that he will be deterred from marriage from the fact that his wife and innocent children will also become, through him, victims of his affliction. Unfortunately the time limits of this inadmissibility to marriage are not the most definite. And more particularly are the ideas upon this subject especially and harmfully indefinite in the minds of many of that very class of physicians which has the treatment of the largest portion of cases whose social relations are important. The feeling that he is doomed to an enforced celibacy is to almost every young man little if anything short of a sentence to imprisonment for life, or even the death sentence itself. It deprives him of the opportunity of carrying to fruition his highest aspirations and plunges him into a gloom which can fall little short of that produced by emasculation. Therefore one of the first and most important tasks is to settle as accurately as possible the date when a syphilitic may safely marry, and in dealing with these unfortunates, one of the highest duties will ever be to give them plain, accurate, concise information upon this subject, and thus set their minds at rest as well



as save them from those errors which are so fatal to social life and for which the surgeon becomes partially responsible if he does not lay down the most strict and definite rules for the patient's guidance.

That there is a date after which a syphilitic may marry seems to be settled beyond a possible doubt. Fournier in his brochure on "Syphilis and Marriage" says that he has record of "eighty-seven observations relative to syphilitic subjects, undoubtedly syphilitic, who, having married, have never communicated to their wives the least suspicious phenomenon; and, what is more, these eighty-seven, have begotten a total of one hundred and fifty-six children absolutely healthy." To this testimony he adds his strong conviction that there is undoubtedly a time after which the syphilitic may marry without danger of contagion either to wife or offspring. In defining the time-limits of the contagious period of syphilis Fournier has discussed the subject from all possible sides, and while not every syphilographer would insist upon his exact mode of treatment nearly all agree with his general deductions as to the time when the syphilitic may marry. He demands fulfillment of five "conditions of the admissibility to marriage:" First. Absence of existing specific lesions. Second. Advanced age of the diathesis. Third. A certain period of absolute immunity consecutive to the last specific manifestations. Fourth. Non-threatening character of the disease. Fifth. Sufficient specific treatment.

The main facts of the case seem to be pretty thoroughly defined and generally accepted as follows: So long as there are present upon a patient any primary or secondary moist lesions, however minute or insignificant, he or she may convey the disease directly or indirectly to the partner or by inheritance to the progeny; tertiary lesions are regarded as non-contagious and non-transferable by inheritance, although it seems quite probable that there are rare exceptions to this rule; during the early months of the disease (young syphilis), even in absence of moist lesions, it is held that a parent is likely to beget a syphilitic child should it happen, fortunately, that the pregnancy does not terminate in miscarriage or premature birth. The earliest time at which Fournier gives any hope of safety for marriage is "three or four" years after the beginning of syphilis, and at least eighteen months after disappearance of active lesions. On the other hand, it is not denied that a child begotten even in the most active stages of the disease may, by accident, as it were, escape hereditary taint. In speaking of the fifth condition Fournier insists that by "sufficient" specific treatment is to be understood an aggressive course of mercurial treatment followed by absence of symptoms, showing the disease to be in a state of abeyance, if not absolutely cured.

A syphilitic father may fail to infect his partner with syphilis and yet convey the disease to his child by inheritance; or it may even happen that the mother, previously healthy, acquires the disease from her child in utero through the utero-placental circulation. This latter circumstance is technically known as "maternal infection" and has been the subject of a tremendous amount of discussion, an account of which cannot consistently be given here. It is sufficient to say that it has been frequently observed that the father being free from active lesions, the wife, having escaped direct infection, is very likely to become syphilitic as soon as she becomes pregnant. Fournier says that where the physician finds a

case in which the husband presents no active lesions and the wife no primary sore and yet she has recently become syphilitic it will invariably turn out that she is pregnant or has recently miscarried or been confined.

This has been so conclusively demonstrated that we must tentatively regard the recently syphilitic father, even in absence of active lesions by which he might infect his wife directly, as dangerous to her, as well as to his offspring, by virtue of the possibility of an element existing in the semen, which, while not capable of producing the disease by inoculation into the adult body is capable of producing it in the ovum by conception.

It is unquestioned that a syphilitic mother may, and almost invariably does, convey the disease to her child although it be conceived of a healthy father. Conception in cases where both parents are syphilitic results more certainly in hereditary infection and in a more aggravated form of disease. If the parents are healthy at the time of conception and the mother acquires the disease at a later date the child may be born healthy or syphilitic (even as late as the seventh month by some authors) or may develop the disease shortly after birth. However late the mother acquires syphilis the disease transferred to her offspring seems to be of the hereditary type and never the acquired. There is not an authentic case upon record where, even in the presence of active lesions in the vagina at term, the mother has inoculated her offspring, producing chancre, and, there is, furthermore, a mass of evidence to show that some apparently healthy children born of mothers having active syphilis are incapable of becoming infected with the disease even by experimental inoculation from another syphilitic. (Profeta's law.)

Hereditary syphilitics, as well as those whose disease was acquired, possess, with very rare exceptions which cannot be doubted, an immunity from the acquired form. This immunity outlasts the active stages of the diathesis and remains during life; but from the fact that reports of re-infection late in the history of the first attack seem to be more frequent than while the diathesis is young, it suggests that there is a tendency toward lessening of the protective power.

There have been reported from time to time cases in which the disease seemed to persist even in the second generation—that is, in which a patient seemed to suffer from hereditary syphilis derived from his grandparents. Sir Jonathan Hutchinson has reported such a case, as also have others; but they cannot be admitted as at all conclusive. The author's position is that there is no reliable evidence that the disease exerts any influence whatever beyond the first generation, much less is there evidence that syphilis itself descends to the grand-child.

**Symptoms and Course of Hereditary Syphilis.**—Hereditary syphilis is treated in many of our text-books in the light of a disease differing widely from the acquired form in its course and symptoms. That marked clinical differences do exist cannot be questioned. It would appear however, that the clearest understanding of the condition is obtained by disabusing the mind of any thought of essential difference in these two types of pox, and at the same time taking into consideration that in the hereditary form we are dealing with the same affection, but that a young infant, or even fetus, whose tissues and vital powers are not yet fully developed, offers little resistance to the progress of this profound constitutional malady. Having in mind a thorough understanding

of the nature, course and symptoms of acquired syphilis as it appears in the strong, vigorous adult, we are accustomed to look for certain variations in its history when the patient is unfortunate enough to be in a weak condition from antecedent or concomitant disease, extreme youth, or extreme old age. Thus "infantile syphilis," the acquired form as it affects the infant, is usually severe, rapid, and oftentimes fatal. The same may be said of malignant precocious syphilis, the form assumed by the disease in debilitated adults, as well as of syphilis recently acquired by old men and women. In studying hereditary disease it must be allowed, first, that the disease has for its victim an undeveloped individual, whose tenor of life is at best not strong, and secondly, that when the patient is first seen, at birth, it has already been syphilitic for a number of weeks and perhaps months—has literally been fed upon syphilis. The consideration of these facts throw a flood of light upon the course of the disease. Indeed, the author believes that if the fetus in utero could be artificially injected with a large dose of syphilitic poison from an extra-maternal source extending over a long period a form of the disease analogous to hereditary syphilis would be produced.

Chancre, so far as is known, is never present in hereditary disease; there is nothing which corresponds in any way to an initial lesion, and the first manifestations are secondary in their type. Some children are born dead without the presence of syphilitic lesions, and in these cases the premature birth is usually due to syphilis of the placenta. A certain portion are born with evident syphilitic manifestations upon their bodies. They look old, weasened, wrinkled and dried up, have a feeble, high-pitched or else a hoarse cry and they fail to gain in weight in the normal ratio. Some of these children present a bullous eruption scattered over the entire body, characterized by some authors as "infantile pemphigus." Again, the eruption may be papulo-pustular in character and involve not only the integument of the body and limbs but that of the palms and soles. The mucous membranes are swollen and inflamed and are at the same time the seat of mucous patches, while the mucocutaneous junctions become excoriated and fissured. There may also be present an obstinate diarrhea due to lesions of the intestinal mucous membranes. "Snuffles" appears and its persistence and severity are often a menace to life from interference with nursing. The succession of macular, papular and vesicular (?) syphilides does not differ from acquired syphilis except that the progress is more rapid, that the thinness and delicacy of the infant's skin tend to produce more excoriations and moist lesions, and that tertiary and deep visceral lesions are more frequently concomitant with the superficial, secondary eruptions. All these moist lesions are exceedingly contagious, and, therefore, the only proper nurse for such a child is the mother, who is of necessity immune. If under efficient treatment the child survives these superficial lesions—and many do not—there is likely to be a period of quiescence of the disease, extending for two or three or perhaps more years, to be followed at five or six years of age by a relapse which is characterized by later papular, pustular, and even ulcerous syphilides. Surviving this attack another critical period is met about the age of puberty when deeper and more destructive lesions frequently develop.

Not every syphilitic child gives evidence of his diathesis at birth.



Diday has furnished most accurate records of the dates of appearance of specific lesions in children and reports that in one hundred and fifty-eight cases syphilis appeared before the end of the first month in eighty-six; during the second month in forty-five; during the third month in fifteen; during the fourth month in seven; the fifth in one; the sixth in one; the eighth in one; and the twenty-fourth in one.

It is claimed by some that there are cases in which the first manifestation of disease is delayed until puberty or later. This class of cases has been much written and talked about under the title "tardy hereditary syphilis," and like many of the other questions in relation to hereditary disease it is still in an unsettled state, the weight of opinion, however, being that such cases do not exist. From the fact that the lesions occurring in these cases are almost invariably late in character, and for other reasons, it is believed that "tardy hereditary syphilis," so-called, is merely a class of cases in which from inconspicuous or poorly observed early lesions the whole history does not appear, and that early lesions did in fact exist.

It is not only upon the skin and mucous membranes that the similarity between acquired and hereditary syphilis is noticed. The organs of special sense and the viscera and bones become affected with a frequency varying inversely with their respective resisting powers.

**EYES.** The earliest manifestation in the eye is an iritis which, if it occurs at all, usually does so during the early stages, at about the same time that the surface presents the macular or papular eruptions. It is not a frequent occurrence but is said to be pathognomonic of syphilis. The cornea is much more frequently attacked than is the iris, but at a later period. Interstitial keratitis begins usually from the eighth to fifteenth year of life, and is at first limited to one eye. It apparently begins as a diffuse haziness near the center of the cornea, but careful examination shows that the haziness is made up of many minute spots situated close together yet distinctly separated from each other. In a few weeks the haziness extends over nearly the whole cornea, giving the "ground-glass cornea" and resulting in proportionate blindness. This condition is attended by some pain, intolerance of light, and the cornea is surrounded by a zone of ciliary injection. In a few weeks or months the other eye is the seat of a similar, although somewhat more rapid, process. Recovery, beginning in the eye first attacked, is accomplished very slowly and rarely is it complete, some slight haziness, and, consequently dimness of vision usually persisting through life.

**EARS.** The ear is often attacked, and although the subject has been only little studied it may safely be said that a large percentage of syphilitic children have either otitis media suppurativa or else a more or less undefined lesion of the auditory apparatus which results in deafness.

**NOSE AND THROAT.** These are not only subject to mucous patches but also deep ulcerative lesions which not infrequently result in perforation of the soft or hard palate, and even more frequently in destruction of a portion of the septum nasi—giving rise to the peculiar deformity of flat nose so characteristic of syphilis.

**VISCERA.** The viscera are the seat of lesions which do not markedly differ from the visceral affections of acquired disease except that they appear earlier, often being concomitant with the superficial eruptions.

The kidney, liver, spleen, lungs, pancreas, each may be the seat of growths or degenerations which are usually even more severe than in the adult, and frequently cause death; of these lesions enlargement of the spleen is the most frequent and is especially important from a diagnostic point of view.

**NERVOUS SYSTEM.** The nervous system suffers in exactly the same way that it does in acquired syphilis. The meninges of the brain and cord and the arteries are frequently diseased, and even gummata develop in the later stages of the disease.

**GENITAL ORGANS.** Both male and female infant genital organs undergo, in many cases, changes which are peculiar, and which, from the fact that sterility is the usual result, are, perhaps, wise provisions of nature to stop the propagation of a weakened and cachectic race. The testicle, one or both, becomes generally infiltrated by a new cell formation followed by thickening and contraction of the interstitial tissue, this resulting in compression and obliteration of the seminiferous tubules. The epididymis usually escapes, although one or two cases have been reported where it was involved and the testicle itself remained unaffected. The penis is small and the seminal fluid contains few or no spermatozoa. In the female the organs retain their infantile size and in some cases menstruation does not occur, while in others it is very irregular.

**TEETH.** The teeth of hereditary syphilitics have been most carefully observed by Mr. Jonathan Hutchinson and as they help to make up a part of the "syphilitic countenance" the liberty is taken of quoting Keyes' impressive description of the syphilitic child's appearance.

"A child who has inherited syphilis, perhaps has never shown marked evidences of the disease in babyhood, becomes somewhat blighted in his development. His skin is coarse, earthy, pallid, perhaps showing cicatrices. He has a squared face, prominent cheek-bones, overhanging forehead, and a sunken bridge to his nose. He looks prematurely old and grave, and may have chronic catarrh, interstitial keratitis, ulceration of the throat, or cicatrices of the mouth or soft palate. The permanent teeth are irregularly set and defective, especially the two middle upper incisors, which Hutchinson calls the 'test-teeth.' These are small, often converging, sometimes diverging. The cutting edge of the teeth is sometimes narrowed and rounded off, whence the name 'pegged teeth.' They are stunted and badly developed, often marked with seams, lines, ridges, in front, and of a dirty-brownish color; but their chief peculiarity is found in their edges, which, being thin, when cut break off centrally, leaving a 'broad, shallow, vertical' notch on the lower border of the tooth. This becomes smoothed down with advancing years, but the size and shape remain to indicate a blighted tooth. Not all children with inherited syphilis have these teeth, but many do, and the sign is well worthy to be carefully watched for."

**BONES.** The bones are even more frequently attacked by hereditary than acquired syphilis. Judging from the locations and characteristics of the osseous changes of hereditary syphilis it seems proper to attribute their frequency to the peculiar qualities of growing bones rather than to any particular characteristic of the inherited syphilitic poison itself. Fournier, in a series of two hundred and twelve cases, of late hereditary syphilis reports eighty-two as having osseous changes and in ninety cases

so affected five cases appeared from the third to the fifth year; in fifty cases, from the fifth to twelfth year; in twenty-four cases, from the thirteenth to the nineteenth year, and in seven cases, from the nineteenth to the twenty-eighth year.

The bones of the skull, the tibia, humerus, ulna and radius are most frequently attacked; and multiple lesions are quite characteristic of syphilis. Without going into the much disputed territory of the pathology of various forms of bone syphilis the lesions may, from their clinical side, be classed as formative and destructive. The former result in development of exostoses and nodes upon the shafts and about the epiphyses of long bones and upon the skull, the latter in disorganization of the bone, with pus-formation in some cases. Periostitis plays an important part in both these processes and the cartilages are frequently involved.

**DACTYLITIS.** This manifestation in both acquired and hereditary syphilis has received attention on page 261.

**Prognosis.**—Statistics of hereditary syphilis give results varying with many conditions. The following may be taken as a general summary resulting from a study of the figures furnished by various observers: The mother being in the active stages of syphilis and untreated or inefficiently treated is very likely—almost sure—to bear a dead or syphilitic child or one who develops syphilis within three months of birth. The same is more strongly the case where both parents are syphilitic and untreated; treatment of the mother during the period of gestation often results in the delivery of a sound child even though she is at the time of conception in the active stage of the disease; the father actively syphilitic and the mother healthy may result in a syphilitic child and syphilis in the mother through the utero-placental circulation, or, the mother escaping infection, may acquire immunity and bear a syphilitic child (*sub judice*); efficient treatment of the father previous to conception under these circumstances saves the child (*sub judice*). A large majority of children born of syphilitic parents develop characteristic lesions within the first six weeks of life. If they pass three months the chances are mostly in favor of their remaining healthy. It is doubtful if the first symptoms ever develop later than one year after birth. This statement denies the belief in a “late hereditary syphilis” unprecedented by even mild symptoms in infancy.

As to the syphilitic child, its chances of attaining adult life are exceedingly slight even under the best of circumstances. Seventy per cent. or over die in infancy, and during the succeeding outbreaks of syphilis they drop by the wayside so certainly that few pass the age of puberty.



## CHAPTER XXVIII.

### TREATMENT OF SYPHILIS.

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**Curability.**—Opinions as to the “curability” of syphilis vary very widely and it would appear that the main cause of variance is a lack of accurate definition of the term in the minds of the disputants. If by “curable” one means that after any stated course of treatment the surgeon can say that the dyscrasia is absolutely eliminated from the system and will never manifest itself again; that late secondary and tertiary lesions can be positively prevented in any given case; that syphilis positively will never develop if this or that treatment is faithfully carried out, then the term has one meaning. If, on the other hand, we use the term “curable” as expressing the fact that each particular lesion as it appears will yield to treatment, but that other lesions or a repetition of this one may occur, and that these “relapses” are also curable by proper treatment, then the term has quite another meaning. Another meaning still is given the word when by “curable” we intend to convey the idea that notwithstanding “relapses,” and even a more or less regular progress of the disease through certain well defined stages, the ultimate result of faithful treatment will be a benign course and in the great majority of cases a final cessation of symptoms at a comparatively early date—admitting, however, that by no means rare exceptions have serious and even fatal late lesions. It is in this latter sense that the author considers syphilis curable.

There can be no doubt that well regulated life, abstemious habits and faithful administration of drugs will cut short any given syphilide or new growth, will lessen the liability to and severity of succeeding outbreaks and will ultimately render the patient free from any evidence of syphilis in the very large majority of cases. It is equally apparent from the experience of the profession at large that there now and then occurs a case which resists all treatment, and in spite of every effort becomes the subject of repeated serious or even fatal lesions.

**Prophylaxis.**—Since syphilis is essentially a venereal disorder and is in the vast majority of cases contracted during illicit intercourse the value of preventive treatment is obvious. If chastity were universal syphilis would probably pass from the face of the earth within a century. But as there has seemed to be little prospect of this state of affairs being reached soon, the attempt has been made in some cities to lessen syphilis as well as attain other objects by passing laws intended to limit prostitution and institute medical supervision of prostitutes. The results have not been especially satisfactory, and the writer is not aware that metropolitan venereal clinics have decreased during the existence of such laws.

Coming now to individuals, it must be said that sexual continence offers the only safety from contagion, and even this is not absolute, else “syphilis insontium” would not be so prevalent as to demand a special

volume for its consideration. There are many expedients which tend to minimize the dangers of contagion, yet none of them are reliable. Theoretically an examination of a prostitute should show whether she is or is not syphilitic, and if syphilitic whether she has or has not active lesions which might convey the disease. Practically, however, such an examination is exceedingly difficult, and even when conducted by an expert is not devoid of sources of error. Careful cleanliness carried out with water or antiseptic solution after an *affaire de la chambre* is likely to wash away any contagious materials, yet it is by no means certain to do so, and besides the frequency and locations of extra-genital chancre indicate that the amorous kiss is little less dangerous than copulation itself. Various lubricants and the condom are employed by those who indulge in illicit intercourse, and are likely to protect the abraded surfaces, yet are far from perfect protectors.

**Abortive Treatment.**—This is both local and constitutional; the former is rapidly becoming a matter of historical interest only, while the latter is of limited applicability. Local abortive treatment may be summed up in the word “excision.” Certain syphilographers still hold that when a sore appears after an incubation period of over twenty-four days, and when its syphilitic nature can be positively demonstrated by both clinical appearances and confrontation with the person from whom the contagion comes, we ought to give the patient the benefit of the possibility of the affection’s still being local, and excise the sore. This of course should be done only when it is advantageously located, e. g., upon the foreskin or sheath of the penis. Acting upon this advice, a large number of cases have received this treatment and the results in hundreds of cases have been reported. These results are not very satisfactory. Some operators have attempted to show that such treatment exempted a small percentage of patients from constitutional symptoms, and that others had a more mild form of disease. Nothing like proof, however, exists and the statistics and arguments have so far failed to arouse even a presumption in the minds of more than a very few of the profession that anything is to be gained by excising a syphilitic chancre. Cauterization, the injection of mercurial solutions beneath the chancre, and the application of antiseptics are even more useless than excision.

Constitutional abortive treatment has received more attention and has more adherents than has excision of the local lesion, and there is an abundance of proof of its effectiveness in lessening the severity and delaying the appearance of early secondary eruptions. There can be no doubt that mercury administered in material doses during the presence of the chancre and during the secondary period of incubation will hasten resolution of the initial sore, as well as procrastinate and even suppress the early syphilides. But there is grave doubt whether it is wise to accomplish these ends in the majority of cases. We are pretty well agreed that such is not the wisest course, but that it is better practice to spend the time from the appearance of chancre to the appearance of general adenopathy, or syphilide, in regulating the patient’s functions and habits and thereby preparing him as it were for “the attack.” The main reason for this view of the best time at which to begin constitutional treatment is that the positive diagnosis of hard chancre is often an exceedingly difficult matter, and authors are agreed that in not a few cases it is absolutely

impossible. Inflammatory induration of benign sores oftentimes simulates so closely the hyperplastic induration of true chancre that this, the most valuable diagnostic symptom, loses a good deal of its value. Not infrequently do we meet sores the history and location of which make their syphilitic nature seem probable, and which by their induration, et cetera, convince most positively that we are dealing with syphilitic chancre, and yet the after history of the patient convinces just as positively that we were not dealing with syphilitic chancre. If now in these cases we share the patient's fright and fly to the use of mercury and it chances that positive signs of syphilis do not develop in a short time we are never able to decide whether our treatment has suppressed or procrastinated the secondary lesions, or whether, upon the other hand, we have another error in diagnosis to add to that list which is ever with us. Thus the patient cannot be given a positive prognosis, and no matter how he lives he is harassed by the possibility of every new pimple being the beginning of an onslaught which has always been looked for and now has finally overtaken him. In other words, while the effect of early or abortive constitutional treatment can be but slight upon the later and more important syphilitic lesions it places the patient, should positive symptoms of syphilis fail to develop early, in a position of uncertainty which is most unpleasant if not seriously harmful.

Notwithstanding then the great stress laid upon the early "abortive" treatment of syphilis by Mr. Jonathan Hutchinson and others, its utility is doubtful, except possibly in cases where the sore threatens the future sexual or urinary function; when confrontation is possible; when situated about the mouth and threatening to expose the patient's secret; when it manifests a dangerous tendency to spread; when occurring in pregnant women, or upon the finger of the surgeon, gynecologist or obstetrician who might infect others.

**Hygienic Treatment.**—This is especially important in syphilis and should be begun as soon as possible. It is, in fact, the only means to be employed in most cases between the appearance of the chancre and onset of the secondary symptoms which establish the diagnosis. During this time the patient should be sent to a dentist to have his teeth and mouth put in the best possible condition. Then, as well as during the future handling of the patient, he should be urged to regulate his habits as reasonably as possible, making arrangements for regular hours of sleep and recreation. His habits should include no excesses. Tobacco should be absolutely tabooed if he wishes to avoid mucous patches, although it is not believed that its use in moderation has an adverse effect upon the disease in any other way. Alcohol is to be absolutely avoided, if possible, but if the patient is an habitual drinker he may be allowed a little red wine with meals. The condition of the digestive apparatus must be carefully investigated and regulated, as well as the condition of the kidneys and other organs.

**Constitutional Treatment.**—**THE EMPIRICAL METHOD.** The method of treating syphilis which is based upon the administration of mercury and the iodides to every patient, regardless of symptoms, is the one which probably finds the most general acceptance in all schools of medicine and has been termed the empirical method simply because it is based, in the medical mind, upon no more scientific principles than



experience. It has been said it is probably the most widely accepted method of treatment; the facts of the case are that among the old school this method is well nigh universal, the main divergence of opinion being in relation to the size of dose, the preparation of mercury used and its method of administration. It must not be forgotten, however, that there are exceptions to this statement. Even as late as 1889 Maximillian von Zeissl decried the routine use of mercury and depended upon the iodides of sodium and potassium. The claim is made by many that some of the late symptoms attributed to syphilis are really to be laid at the door of mercury. Nevertheless, anti-mercurialists are hardly known, in this country at least.

In the homeopathic school of medicine there is a great tendency to place reliance upon the routine use of mercury and the iodides rather than upon the strictly homeopathic method, which demands individualization of each case and a prescription based upon the symptoms of the case and the law of similars. Many homeopaths, however, excuse this by the claim that mercury and iodide of potash are homeopathic to the conditions. This appears to be merely a subterfuge; for syphilis presents as many variations in its course as any disease and it must be a strange coincidence indeed that pneumonia, for instance, may demand almost any drug in the *materia medica*, while syphilis is to their minds met by two drugs.

The various modifications of the empirical method are so numerous and vary so slightly one from another that an exhaustive description of them finds a better place in a special work than in a work on general surgery. It will be sufficient to give a detailed description of the method which is considered best, and then describe the modifications which may be demanded by special circumstances.

The "tonic treatment" of Keyes is the most rational, the most widely followed in America, and, so far as can at present be ascertained, gives as good results as any method, while at the same time avoiding the bad effects of extremely large doses of mercury. It is based upon the continuous administration of a "tonic dose" of some preparation of mercury for a long period of time and regardless of the patient's condition—i. e., absence of symptoms does not in itself warrant a discontinuance of treatment. Treatment is continued for a period, varying with the circumstances of the case, of from one to three years.

The tonic dose varies with different patients and is ascertained, to use Keyes' own words, as follows:

"The standard fractional dose being selected, preferably in form of granules—one-sixth grain of protiodide (one centigramme), one half-grain blue mass, one-thirtieth grain bichloride—it remains to find the "full dose" and the "tonic dose." No combination containing opium can be used in selecting a standard fractional dose. The diet and habit should be regulated, and the course commenced by causing the patient to take one granule of the standard (I prefer the Garnieo and Lamoreux one-centigramme granule) preparation immediately after each meal for three days—that is, three a day. For the next three days he takes four a day (one in the morning, two at noon, and one at night); then, for three days, five a day (two in the morning, one at noon, and two at night); then, for three days, six a day (two in the morning, two at noon, and two at night);

then, for three days, seven a day (two in the morning, three at noon, and two at night); then eight, and so on, adding one granule to the daily dose each fourth day—if there is reason for haste I make it each third day—until pernicious medicinal effects of mercury begin to show themselves, which are, with the protiodide, usually griping pains in the abdomen, and at least two free watery stools a day. An occasional pain I pay no attention to, and free movements of the bowels I do not regard so long as these movements are not watery. Mild, colicky diarrhea is what I wait for, and when this comes I write down the daily number of pills required to produce it, and name this number the “full dose.” Such a dose may, and usually does, promptly control syphilitic symptoms, and it may be maintained and its obvious objectionable features done away with by giving the patient a certain number of half-grain granules of opium to take along with his protiodide. If blue pill, gray powder, or bichloride be used the full dose may first announce itself by commencing irritation at the mouth before the intestines show disturbance. This full dose cannot be maintained without injuring the patient, and it must be used only for a short time when required for emergencies.

“Half the full dose is the ‘tonic dose,’ and sometimes one-third the full dose is all the patient requires to keep him moderately free from symptoms, which is all he can ask.”

It is believed this is the best method of treating early syphilis by mercury and only one suggestion is offered, a suggestion which comes from the broad experience of Doughty of New York. Believing that there is no principle in therapeutics more thoroughly demonstrated than that trituration of certain drugs with milk sugar increases their power many-fold—call it minute subdivision, dynamization, potentization or what-not—it is found wise to substitute for the granules above described, in which the protiodide of mercury is in a crude mass, the 1-25 grain or 1-100 grain tablet triturates prepared by any of our reliable pharmacists. These tablets have a much more marked effect, grain for grain, of mercury than do the granules, therefore a smaller dose of the drug is required than when it is not triturated. If at the beginning or during this course of treatment any syphilitic accidents or complications become severe and the continuance of the “tonic dose” does not control them, a larger dose may be employed temporarily; or, what is better, a course of inunction, fumigation or hypodermic injections may be resorted to, and even though the amount of mercury is not materially increased the mere employment of a new avenue of entrance of the drug seems to increase its efficacy.

**OTHER METHODS OF ADMINISTERING MERCURY.** Inunction of a portion of the body with mercurial ointment is one of the oldest and most reliable methods of employment. In this country it is rarely used as a routine treatment, but is used rather to bring the patient quickly under the influence of the drug in order to combat severe lesions. The best method of using inunctions is to instruct the patient to anoint the antero-internal surface of the left arm just before retiring with vaseline and then, taking about a third of a teaspoonful of mercurial ointment, to thoroughly rub it into the part with the bare hand, taking fifteen or twenty minutes for the operation. The next night the antero-internal surface of the left thigh is treated in the same manner, then the

right thigh, right arm and then around this circle again. If it is found that the second inunction of a given surface causes unpleasant irritation of the skin, other surfaces of the body may be used, e.g., the sides of the thorax, loins, etc. It is wise to advise the patient to devote a special suit of underclothing to his use during the periods of inunction in order to protect his other clothing as well as the bed-linen from being soiled. Under the method of treatment which has been described the cases requiring inunction are very rare; it is, however, preferred by many foreign surgeons as a routine treatment, notwithstanding the fact of inaccurate dosage and filthiness.

Inunctions must not be persisted in too long and the patient's mouth and gums are to be carefully watched for the appearance of the characteristic red line, spongy gums, or ropy saliva, which should give warning before salivation is produced. In cases where syphilis is complicated by tuberculosis it is found that cinnibar seems to have a more marked effect than does the protiodide recommended above.

MERCURIAL VAPOR BATHS. These are used even less frequently than inunctions, but are invaluable in some cases, especially those of persistent eruptions distributed over large surfaces of the body. The method of employing the vapor bath is by means of some of the lamps made for the purpose, or by use of an extemporaneous apparatus made by so bending the ends of a piece of sheet-tin that it forms a sort of a table under which an alcohol lamp is set and upon which the dose of about thirty grains of calomel is placed. This vaporizer is to be placed beneath a cane-seated chair upon which the patient sits naked, with a blanket pinned around him like a tent. The warmth of the alcohol flame vaporizes the mercury and at the same time causes the patient to perspire slightly, so that the mercury is deposited upon and adheres to the skin. About twenty minutes is spent in the bath and the patient remains in his blanket a few minutes after the flame is extinguished in order to cool off. He should not take the bath without the presence of a nurse or attendant, as syncope sometimes results and there is danger of the blanket catching fire if such an accident should happen. The mercurial vapor bath may be repeated every second, third, or fourth day as is deemed necessary.

HYPODERMIC INJECTION OF MERCURY. This method of administering the drug is still upon trial and is meeting a great deal of criticism. The preparation most used is corrosive sublimate in doses of from one-twelfth to one-fourth of a grain dissolved in twenty drops of water and administered every second or third day. It is to be used only in emergencies.

IODIDES OF POTASSIUM AND SODIUM. As syphilis advances in age the preparations of mercury become less active in controlling various lesions. Then it is that the iodides of sodium and potassium are of the greatest use. The iodide of potash is the remedy usually employed and its action is even more certain and definite upon late secondary and tertiary lesions than is mercury upon primary and early secondary syphilis. The exact period at which the iodide of potash should supersede mercury or be given simultaneously is not marked by definite signs any more than is the transition from secondary to tertiary lesions in a given case. However, the two events are not far apart and in general it may be said that the older the syphilis the more likely is iodide of potash



to be the remedy rather than mercury. As the lesions show a tendency to become deeper-seated, ulcerative, and asymmetrical mercury ceases to be as active and they seem in most cases to respond quickly to iodide of potash. The ordinary and best method of administering this drug is to have prepared a saturated solution in water; this is to be given in gradually increasing doses until the lesions yield or until the appearance of gastro-intestinal irritation, a fluent coryza, skin eruption, or tinnitus aurium announces iodine poisoning. These symptoms will best be avoided and the patient enabled to take the largest dose by administering the iodide in a full glass of water or milk, from one-half to one hour after meals, and followed in a short while by another glass of water. In adults it is customary to begin with three to five drops after each meal and gradually increase the dose, remembering that each minim of the saturated solution represents a grain of the drug, while the quantity in each drop varies with the circumstances of its formation. The daily dose required to control tertiary lesions varies from fifteen to over two hundred grains, and the dose capable of producing iodism varies almost as widely. It must be remarked that oftentimes a small dose will cause slight symptoms of iodism at first, while, if persisted in, they may pass away, and that a dose which produces iodism in a patient while residing in one locality may often be doubled without serious effect provided the patient is given the advantage of a change of climate and occupation. In children drop doses may be given as above.

It appears wise in many cases to begin the use of iodide of potash before mercury is discontinued—in other words to use the “mixed treatment.” As the two drugs seem not to interfere with each other they can be administered simultaneously or, preferably, in separate doses, giving the tablets of protiodide before meals and the solution of iodide of potash after meals. This is used as a routine treatment by some, and with excellent results.

Late syphilis sometimes fails to yield to the iodide of potash or it is not well tolerated, while the iodide of soda seems to act quickly and surely. Some of the most stubborn cases of old syphilis will not be materially affected by any of the iodides, yet will be cured by some preparation of gold, and a combination of gold and mercury has recently satisfactorily relieved a case of gummatous periostitis for the author which the iodides, although tolerated in large doses, did not affect; other cases of tertiary syphilis after running the whole gamut of empirical measures are cured, and that very quickly, by the application of the homeopathic remedy in potency.

**HOMEOPATHIC TREATMENT OF SYPHILIS.** This has received altogether too little attention, both in our practice and in our text-books. When the word homeopathic is used the prescription of drugs for syphilitic manifestations because those drugs produce in the well person symptoms similar to the symptoms seen in syphilis is meant. Although mercury and iodide of potash produce some symptoms resembling syphilis, we are not treating syphilis homeopathically when we administer them simply because the patient has syphilis and without a comparison of their symptoms with those of the patient. True, it may chance that an empirical prescription agrees with the homeopathic prescription, but it is empirical nevertheless. Many physicians of wide experience rely upon the symp-

tomatic-homeopathic treatment of syphilis and do not administer mercury and the iodides in a routine manner at all, and they report excellent results. The only guide for such treatment is to follow the law *similia similibus curantur*, and it is believed that any drug in the *materia medica* may, in one case or another, be the homeopathic and, therefore, the curative remedy. Asafetida, acidum fluoricum, acid nitricum, arsenicum iodatum, arsenicum aurum, carbo animalis, carbo vegetabilis, cinnabaris, corallium rubrum, cannabis, graphites, guaiacum, hepar sulphur, iodine, kali bichromicum, kali iodatum, kreosotum, mercurius, mercurius protiodide, mercurius biniodide, mezereum, natrum muriaticum, phosphorus, psorinum, silicia, stillingia, sulphur and thuja form a summarized list, from which to choose according to special indications.

**SPECIAL INDICATIONS.** If Hahnemann had done nothing more than to give to the profession the soluble form of mercury which bears his name he would yet be deserving of the gratitude of both prescribers and takers of this drug. For the indurated chancre there is no better remedy than *mercurius solubilis Hahnemanni*. The simple soft chancre heals within a short time under its use, whereas the hard chancre will be benefited by it, though perhaps requiring other remedies as well. It covers spreading and deeply eating ulcers on the glands and prepuce; painful bleeding chancres with yellowish, fetid discharge; small chancres with cheesy base and inverted edges that are red and irritable; ulcers with lardaceous bottoms and hard edges. This soluble form of mercury may be administered with moderate safety in low potency over a number of days, but if clearly indicated its action in the medium potencies is equally satisfactory.

*Mercurius corrosivus* will be called for in chancres that are indurated and excessively painful, with a good deal of swelling and inflammation surrounding them. It is applicable also to soft chancres that are dark red, painful and bleed easily; chancres that appear upon the surfaces of the preputium or corona glandis, whose bases are covered with ichor, adhering firmly. *Mercurius corrosivus* is also applicable to destructive soft chancres and syphilitic ulcers in the mouth and on the gums.

Cinnabaris is a preparation of mercury that meets symptoms presenting a combination of those of syphilis and sycosis. Fan-shaped condylomata on the penis, with redness and swelling of the prepuce; blennorrhea of the glans; red, swollen chancres with hard, elevated edges, not sensitive or painful as with *mercurius corrosivus*. The distinguishing symptom between the two remedies in the same type of chancre is the painfulness of the one and the painlessness of the other.

Nitric acid is especially useful in the nightly bone pains of syphilis, but is also applicable to spreading, superficial, phagedenic chancres of the disease. Syphilitic ulcers that bleed easily when touched and that are exuberant with granulations call for nitric acid. This remedy is also useful in the light forms of moist condylomata, vaginal ulcers, copper-colored spots about the anus, syphilitic ulcers in the mouth, and many of the nerve symptoms of the disease.

Thuja is an excellent remedy for dry condylomata and other sycotic symptoms. It is occasionally beneficial as an intercurrent remedy in the treatment of soft chancre, though more frequently applicable to the dry lesions of the syphilitic subject.

Phytolacca is a remedy of value in syphilitic rheumatism and secondary eruptions, especially over the limbs. It is also beneficial in the syphilitic ulcerations of the throat seen in association with rheumatism.

Kali bichromicum is perhaps the most curative of all remedies in syphilitic affections of the mouth and fauces. It is also an excellent remedy in syphilitic ulceration of the nares. It is not often beneficial in the primary stage of the disease, its pathogenesis being limited primarily to indurated chancres that ulcerate deeply and in which there are itching and burning sensations.

Fluoric acid will be found useful in syphilitic ulcerations of the mouth and throat, with syphilitic caries and necrosis of the nasal and palatine bones. It is also applicable to syphilitic caries and necrosis of the long bones and of the skull.

Aurum metallicum, next to nitric acid, is indicated in syphilis of bone. It has boring pains in the mastoid process, caries of the nasal bones and nodes on the legs. The bones of the skull are painful when lying upon them. Aurum is also applicable to severe syphilitic headaches, due, doubtless, to adventitious deposits within the brain.

Arsenicum, especially the jodatum, is applicable to phagedenic chancres of livid hue, with deep sloughing and intense burning. This remedy also covers many of the secondary and tertiary symptoms of syphilis, as mucous plaques, cutaneous ulcers, greenish pus, coffee-colored eruption on the skin, buboes that assume a gangrenous aspect, the neighboring glands being swollen, indurated and painful.

Asafetida covers tertiary syphilis with deep-seated inflammation and soreness from this cause. Syphilitic caries and necrosis, with fetid and bloody discharge. Nightly bone and nerve pains due to syphilis are often relieved by it. Ulcers of the shin bones that are sensitive to touch call for asafetida.

Mezereum is applicable to syphilitic periostitis; nightly bone pains throughout the entire system; bones inflamed, swollen and sensitive to the least touch, especially the shafts of the long bones. Nightly headache, and in special cases constant headache from topi of the skull.

Besides the remedies for which a brief resume of special symptoms has been given, others that may be mentioned in connection with the various forms of syphilis are lachesis for syphilitic aphonia with ulceration of the throat which bleeds easily, caries of the tibia, with adjacent tissues sensitive and livid; conium, indurated, hard chancre of long standing with syphilitic sarcocoele; hepar sulphur, especially applicable to syphilitic diseases of the gums, which are unhealthy, spongy and bleed easily; badiaga, syphilis of infants, and also hard or indurated buboes; benzoic acid, syphilis with widespread markings over the body with syphilitic rheumatism, and condylomata about the anus; carbo animalis, constitutional or tertiary syphilis with copper-colored blotches on the skin, also in the secondary lesion with buboes as hard as stone; kreosotum, especially applicable in syphilitic affections of the teeth and severe bone pains, worse at night.

Other remedies that may be required in special cases are staphisagria, natrum sulphuricum, aurum muriaticum, carbo vegetabilis, phosphoric acid, sepia, iodum and lycopodium. Syphilinum has been warmly recommended by authors who believe in the use of nosodes. Experience with it is limited and not very satisfactory.



**Local Treatment.**—**CHANCER.** Those primary lesions which are not attended with solution of continuity or loss of substance require no local applications. In fact, the majority of syphilitic chancres will take care of themselves about as well as the surgeon can take care of them. However, no harm is done and healing is sometimes hastened if they are treated upon ordinary surgical principles. The application of antiseptics, too numerous to mention, has been advised, but it does not appear that one possesses a great advantage over another. Aristol, eucrophen, and a mixture of equal parts of boracic acid and iodoform are useful. If there is much suppuration or phagedenic ulceration it is good practice to clean the sore with hydrogen peroxide and apply whatever powder is chosen directly to the sore. Some sluggish sores are benefited by the use of a strong solution or even the stick of nitrate of silver, while others are best treated by moist applications. One of the very best moist treatments is to apply with a probe wrapped with cotton a solution of permanganate of potash, sixty grains to the ounce, and then keep the sore dressed with absorbent gauze moistened with a two-grain to the ounce solution of the same drug.

Mucous patches of the mouth are prevented very largely by careful cleansing of the mouth three times daily with a saturated solution of chlorate of potash, and the avoidance of tobacco, as well as of the use of irritating food or liquids. When patches appear they are usually quickly healed by the single application of the stick of nitrate of silver, brushing the patch over lightly if it is superficial and cauterizing it more thoroughly if it is deep. The surgeon must be sure to dry the region of the patch carefully before applying the caustic, in order to avoid the formation of a solution in the saliva which may burn healthy mucous membrane.

Deep ulcerations in the mouth and throat often progress very rapidly and are not favorably affected by the weaker caustics. These sores should be carefully but thoroughly cauterized with pure nitric acid, extreme care being taken to apply the acid to the diseased surface only, and to be sure that it does not drop or run off the applicator upon healthy tissue.

Mucous patches upon the skin and condylomata are best treated by keeping them absolutely dry, by dusting with calomel powder or any of the simple powders. Severe lesions of this description require the nitric acid applied in the same way as directed for deep ulcerations in the throat.

Pustular and ulcerating syphilides are benefited by applications of the Ung. Hydrargyri oxidi rubrum or an ointment made with oxide of zinc as follows:

R.

Hydrargyri oxidi rub. . . . . two drachms

Unguent zinci oxide. . . . . six drachms

This to be applied twice daily to the ulcers, after removing all crusts and discharges.

**Treatment of Hereditary Syphilis.**—The same general treatment is demanded as in the acquired form, the only modifications necessary being those arising from the tender age of the patient and consequent difficulty in administering the drugs. The hygienic care of syphilitic infants is all important. They should be nursed by their mothers for two reasons; first, because, although the milk of a syphilitic woman has

been shown to be poor in quality, the child stands a far better chance of life than by any method of artificial feeding; and, second, because it is absolutely unjustifiable to employ a healthy wet nurse to suckle a syphilitic infant, since she is almost sure to acquire the disease.

The administration of mercury should be commenced as soon as the first symptoms of syphilis appear, and in case of a child born of a recently syphilitic mother it is wise to anticipate the lesions which the child is almost sure to develop. The methods of administration are various. Calomel may be given by the stomach in doses of one-twentieth to one-sixth of a grain three times daily. Keyes recommends the use of a solution of half a grain of the bichloride of mercury in six ounces of water, one teaspoonful to be given in milk or water every three or four hours. Inunction is carried out by applying to the infant a piece of cloth large enough to cover nearly the whole abdomen; this cloth, being spread with mercurial ointment diluted with an equal weight of petrolatum, is bound upon the child daily. In order to avoid irritation of the skin it is changed from front to back or to the sides as seems necessary. The child's movements supply the requisite amount of friction; this method is one of the best and most reliable.

Exactly as in acquired syphilis the iodide of potash is indicated by lesions which partake of tertiary characteristics; it is given in doses varying from a half grain to ten grains three times daily, well diluted in milk. Local measures are practically the same as are demanded in acquired syphilis.

## SECTION VII. BURNS AND SCALDS.

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### CHAPTER I. GENERAL CONSIDERATIONS.

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**Etiology.**—Burns and scalds are the result of the direct application of heat to the human tissues. The surgical state is practically the same whether the injury is caused by the application of flame, heated metal, molten metal, or purely liquid substances; therefore burns and scalds are properly deserving of consideration as injuries of the same class and character.

The most common causes of severe burns are direct contact with flame from burning material, as in a burning building, steamboat, hotel and railway accidents, burning of the clothing while on the body, explosion of lamps, or other vessels containing oil. In the case of children, infirm, and intoxicated individuals there is an added liability of falling into the fire. Scalds are usually the result of explosion of boilers, whereby escaping steam and boiling water are brought in contact with the tissues, and in children, domestics and housewives are often the result of the upsetting of scalding water from cooking and other household utensils. Occasionally a scald is produced by attempts at too rapid drying of wet clothing before a hot fire. A case of this character came under the author's observation recently, a domestic suffering a severe scald of the thigh from efforts at rapid drying of a wet garment on her person before a hot fire.

Severe burns are sometimes the result of explosions of powder, the hands and face especially suffering from this cause.

**Divisions.**—Dupuytren, whose classification is followed by many authors, separates accidents of this character into six divisions; viz.: (1) hyperemia; (2) vesication; (3) superficial destruction of the corium; (4) destruction of the whole thickness of the skin; (5) injury to the muscular and connective tissues; (6) injuries to or destruction of all tissues, as the muscular, connective and vascular tissues and bone.

**BURNS OF THE FIRST DEGREE.** Hyperemia, or simple redness, swelling and inflammation of the skin, without vesication, results from simple contact of hot air or flame or sun-heat with the integument. It is not usually severe, though sometimes attended by much pain. If a large area of integument be involved there may be profound constitutional



symptoms, as chilliness, shock, collapse, depression of the pulse and temperature, etc. Such symptoms have been met with as the result of extensive sun-burn-hyperemia from prolonged exposure of bathers. First degree burns may be fatal, in fact are nearly always so if one-half of the body be involved. (Moullin.)

**BURNS OF THE SECOND DEGREE.** These are characterized by the formation of bullæ. These may be of small size and numerous, or single large blisters may form. In scalds they may be as large as the hand, or larger. Burns of this degree are usually more painful than hyperemic burns, though not always so. The bullæ which are formed are filled with a clear liquid, which, as they burst, escapes over surrounding tissues, leaving the blisters empty and collapsed. If the liquid is tinged with blood the injury is of a severer degree, the corium being then involved. Burns of the second degree are not likely to leave scars, but sufficient change in color marks the site of the injury to make it noticeable for months or years.

**BURNS OF THE THIRD DEGREE.** This degree involves the corium, with superficial destruction of the skin. As in the preceding variety there is vesication but the contents of the bullæ are of a dark brown color, from effusion of blood from the capillaries. The pain is usually more pronounced than in either of the preceding degrees, and that the injury is more severe is shown by the fact that the burned area assumes a yellowish or grayish color, with an areola of redness surrounding it; so that the evidence of the first, second and third varieties of injury are present at once. Not only is the pain more severe from the moment of the injury, but it is aggravated as sloughing and suppurative fever occurs; even if not especially marked at first pain is likely to be complained of at this time.

Burns of the second and third degrees, when not pronounced, may so blend together at first as to be more or less inseparable as regards classification. The difference in color of liquid in the bullæ, the occurrence of suppurative fever, secondary pain and sloughing will, however, readily determine the involvement of the corium. Those of the third degree so seriously affect the papillæ and corium tissue that restoration is quite out of the question and a permanent scar is left.

**BURNS OF THE FOURTH DEGREE.** In this classification of Dupuytren the entire skin is involved in the destruction. The injury has been so severe that the skin is at once destroyed without vesication having occurred. Individual cases are seen in which there will be present in a single burn evidence of all the degrees described, an outer areola, as simple hyperemia-vesication, with transparent or opaque bullæ next, then moderate vesication with blisters filled with a brownish fluid, and complete destruction of a central area, which is covered with a tough or hard eschar, sometimes curled up at its edges and as dry as leather.

In burns strictly of fourth degree there is not usually much pain at first, the severest manifestation consisting of shock. With reaction, however, the suffering may be really agonizing. Deep, sloughing follows burns of this degree and as cicatrization takes place contraction occurs. In severe cases the contraction of scar tissues may be so pronounced as to cause severe, even hideous, deformity.

**BURNS OF THE FIFTH DEGREE.** These are more serious, and more dangerous to life from the fact that they involve the deeper tissues. Not only is the skin destroyed but the connective tissue and muscular structures are involved. If the abdomen or flank be the site of the injury a fatal result may quickly ensue. Unusually severe burns in the femoral or axillary region may destroy life by hemorrhage, while a general septic state may ensue from severe injury to deep tissues. The symptoms and contraction are much the same as in burns of the fourth degree.

**BURNS OF THE SIXTH DEGREE.** In this class the bony system suffers as well as the soft tissues. A foot, hand or limb, or portion thereof, may have been completely destroyed, or the skull or one or more ribs may have suffered. In one case occurring in the author's practice a drunken man suffered a severe, almost fatal, burn of the head, involving the left parietal bone, and in another case an intoxicated man was horribly burned on the chest and face by falling in the fire, the sternum and portions of two ribs being severely necrosed by the injury.

A burn of the first degree may result fatally, while that of the sixth may cause but the loss of a limb. In burns of the last mentioned class healing is always slow, deep sloughing occurs, with great proneness to metastatic abscesses, and as sloughs separate severe, even alarming, hemorrhage may result.

**Constitutional Symptoms.**—**PAIN.** Slight burns and scalds cause but little more in the way of constitutional disturbance than pain. This is out of proportion to the apparent extent of the injury, and may be more severe in simple hyperemia than in deeper burns. It is burning, stinging, biting in character, and is aggravated by exposure of the injured surface to the atmosphere or to touch. In rare instances even slight burns will cause reflex disturbances, as nausea, vomiting and diarrhea, and sometimes headache and fever.

**SHOCK.** No injury to which the human system is liable is more productive of shock than a severe burn. Nor is it necessary that the injury should be of the sixth, fifth or even fourth degree to induce severe, even fatal, shock. In fact, shock belongs to extensive destruction of integument rather than to the depth of burns. In one of the author's cases a lady died from shock twenty-four hours after being badly burned by the burning of her clothing while on her body, the fire having been communicated to her dress while burning grass in her door-yard. She was burned from ankles to occiput and the skin was cooked under the direct application of the flame so that it rolled up in dry, shriveled folds. She suffered no pain, but was "freezing cold." The pulse fell to forty beats per minute, the temperature registering but 97.5 degrees, at which it continued until within an hour or two of her death, when it fell still lower. Her freedom from pain seemed to be complete, but she never recovered bodily warmth, expressing herself as dying from cold. Not all burns of this degree produce such severe shock, but it is seen in a large proportion of severe burns. It is not unusual in hotel fires to witness the death of numbers of patients from shock rather than from the depth of the burns.

**COLLAPSE.** Clinically, collapse is but an aggravated degree of shock. Yet for purposes of comparative description the terms are here used separately. The case last cited was typically one of shock. Occasionally



a case is met with in which there will be, besides the symptoms enumerated, profound disturbance of the sympathetic system. Diarrhea, vomiting, sweats over unburned integument, dyspnea, and mental disturbance will characterize it from shock as described. In the shock of burns the mind is usually clear, while in collapse the patient is so obtunded as to know but little if anything of what is going on about him. The distinction is not of special significance, except that where the sympathetic system is involved, as in collapse, reaction is more likely to ensue and is apt to be proportionate to the severity of the collapse.

**REACTION.** Following shock and collapse there is, in recoverable cases, a stage of reaction that is important. There will be an improvement in the pulse and a gradual return of the normal bodily warmth, and, later, a considerable rise above the normal; and as the sensibilities of the patient are restored there may be suffering in proportion to the degree of collapse or shock. During reaction the pain will be severe unless proper measures are instituted to give relief. Sometimes pain is severe enough to cause secondary shock, and only by gradations will the patient return to his normal equilibrium. The pain is always more intense in superficial burns extending over considerable area where it is impossible to protect the skin from the air.

**SUPPURATION.** Suppuration is no longer a necessary attendant upon burns if proper antiseptic precautions are promptly observed. But because the surgeon is not on the ground at the time the injury is inflicted wound-pollution will have occurred in most instances before he sees the case. In other cases the nature and extent of the injury precludes the possibility of absolute success in the attempt to follow antiseptic measures, and wound-contamination in some degree is the result, suppuration following infection. This lasts from a day or two to two or three weeks, depending upon the extent of injury, the depth of the burns and the constitutional state of the patient. Chilly sensations, even a positive chill, followed by more or less continued elevation of temperature may attend or succeed the formation of pus. In severe cases and especially in debilitated or unhealthy subjects, this process is protracted where the lesion is extensive, and systemic states that attend upon suppurating wounds are present to threaten and destroy life. Long continued or profuse suppuration from a burn brings the additional danger of extension of destruction by local sepsis, hence the manifest necessity of the strictest possible antiseptic measures in every case of injury of this character. The greater the difficulty of practicing antisepsis the greater the necessity therefor.

**EXHAUSTION.** Exhaustion follows upon cases suffering extensive sloughing and suppuration. The symptoms will be the same as in similar cases from other causes. Exhaustion is not likely to ensue upon the sloughing of local tissue alone, but generally follows septicemia.

**Pathology.**—In superficial burns the pathological changes will be confined to the skin, primarily. In cases dying from shock there are no characteristic pathological manifestations. During the stage of reaction, congestion and sometimes inflammation of internal organs occur, more especially of the brain and lungs. Ulceration of the duodenum follows local congestion of its membrane, sometimes occurring as early as the fourth or fifth day, in other cases not showing until the end of the second or third week. Congestion is unquestionably due to reflex paralysis of the



vessels, although heart-paralysis, embolism and blood-changes have been charged with the causation of the condition. Shock is perhaps the severest of all the influences operating upon the organs congested; and it is not for a number of days after the disappearance of severe shock that the tissues and organs of the body regain their vigor. As a rule, congestion of the brain and lungs is not in proportion to the degree of burn, that is, to its size or depth; superficial burns will sometimes be attended by severe congestions. The inhalation of steam causes violent, even fatal, congestion of the lungs. Acute broncho-pneumonia may likewise follow this accident.

Naturally, burns upon the extremities are not as likely to produce congestion of the vital organs as those occurring about the head, chest and abdomen. If the face has been the site of injury, or if there has been inhalation of steam, or flame, beside destruction of the skin and mucous membrane there may be fatal edema of the glottis. The ulcers of the duodenum are sharply defined, almost as if cut out with a shoe-punch, and may be one or several in number. Sometimes they extend through the intestine, which then empties its contents into the peritoneal cavity and induces peritonitis; or, perhaps, by destroying a blood-vessel death from internal hemorrhage is induced. They do not always destroy the intestine, however, and if only the superficial coats are involved in the ulcer cicatrization will occur and recovery of the patient follow. Narrowing of the lumen of the bowel may result from this cause. It is explained that the probable cause of the duodenal ulcers is the effect upon the duodenal glands of gastric juice altered by congestion of the gastric membrane, or they may be the result of embolism. Congestion of the stomach is not found to follow even severe burns, and thus the condition is rendered even more inexplicable. It may be assumed that the anatomical relations of the skin and mucous membrane of the duodenum are so intimate that this may have something to do with it by process of metastasis; but this explanation is faulty in that other divisions of intestinal membrane would also show metastatic congestion besides the duodenum. The clinical fact of duodenal ulceration exists without satisfactory explanation.

**Complications and Sequelæ.**—Besides duodenal ulceration, pleurisy, pneumonia, enteritis, peritonitis, synovitis and general septicemia are known to follow severe burns. During the stage of reaction there may be an acute circumscribed pneumonia with cough, rapid breathing, pain in the lung, rusty expectoration, slight hemorrhagic indications and the characteristic physical signs. In other cases, not so severe, pulmonary engorgement occurs with rapid and difficult breathing, increased rapidity and tension of the pulse, elevated temperature and blood-stained sputum, but without the lesions of pneumonia. Pleurisy and pericarditis follow severe burns, and synovitis is not an infrequent septic sequel, especially from burns of the extremities. If the suppurative process is general septicemia is a possible complication, and from long continued suppuration amyloid degeneration of the kidneys and general constitutional exhaustion may occur to complicate and terminate the case. Erysipelas follows badly treated or infected burn-wounds in occasional instances.

**Prognosis.**—The danger in burns is great in proportion to the external extent of the injury. Burns that penetrate deep into the

muscular tissues of the body, even destroying large blood-vessels, are not especially likely to be attended by fatality except from hemorrhage, and this rarely occurs at the time of the injury. Alarming, even fatal hemorrhage is seen as sloughs and eschars are separated. The chief immediate danger in burns of the external surface of the body lies in the degree of shock that is experienced, this being in proportion to the integumentary area that suffers. Burns of the first or of the second degree may be fatal if one-half or more of the integumentary surface is affected, and are more dangerous to children and infirm and delicate subjects whose nervous systems yield to the severe shock incident to the burn and the fright that goes with the accident. Burns about the chest, abdomen, and head, are naturally more dangerous than those affecting the limbs and other portions of the trunk. Inhalations of fire and steam cause death from edema of the glottis and acute inflammation of the larynx and lungs. Congestion of the brain, lungs or kidneys may cause death, while Curling's duodenal ulcer is among the most frequent causes of secondary mortality. General septicemia, with metastatic abscesses in almost any part of the body, may cause a fatal result in cases characterized by suppuration, especially where antiseptic precautions and free drainage are neglected. In rare instances, especially in children, convulsions occurring as a direct result of the injury or as a secondary process, due to the cerebral congestion or embolism, may bring about a fatal issue.

## CHAPTER II.

### TREATMENT OF BURNS.

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**Classification.**—The treatment of burns comprises the application of local and constitutional measures. The former are directed with special reference to the exclusion of air and allayment of local irritation and pain. Constitutional treatment must be directed toward securing reaction from shock, relief from the severe pain that follows and the support of the general system with reference to overcoming shock, reaction and subsequent exhaustion.

**Local Treatment.**—The local treatment of slight burns contemplates exclusion of the air from the injured surface by the immediate application of such remedies as are at hand. Among the very best of these are a saturated solution of bicarbonate of soda, or a solution of phenol-sodique in the proportion of one part to eight of sterilized water. A thick paste made of bicarbonate of soda and olive oil is an excellent local application. Thorough antisepsis should be practiced in all burns beyond those of the first degree. The free application of iodoform-ointment, or iodoform with the subsequent application of large pledgets of sterilized gauze, securely bound over the injured surfaces, may be the only dressing required. Should suppuration ensue, and especially where the deeper tissues are injured, the free use of peroxide of hydrogen, followed by a warm solution of boracic acid, with the subsequent application of iodoform and efforts at the exclusion of air, will be demanded. Bullæ should be opened with an aseptic needle, thoroughly dusted with iodoform, or other selected antiseptic and dressed with aseptic cotton. To prevent the dressings from adhering to the wound they may be laid upon perforated Lister's protective.

The dressings of burns should not be changed often, but when removed all pus should be cleared away with peroxide of hydrogen, sloughing tissues should be removed as rapidly as loosened, and iodoform, boracic acid, or other selected antiseptic dressing should be immediately applied. Gauze compresses kept constantly wet with Thiersch's solution is an excellent dressing. Carbolic acid is irritating to burns, while the local use of corrosive sublimate in areas is likely to prove dangerous, especially in children and infirm subjects. Carron oil, a mixture of linseed oil and lime water, has been extensively recommended and applied for a good many years. It modifies the pain but is offensive and soon becomes a nasty dressing. The local application of a weak solution of cantharis is among the best remedies for the relief of the pain of burns of the first and second degree.

Dry applications, as baking flour, Fuller's earth, powdered clay, finely powdered willow charcoal, have been used in domestic practices with more or less success in burns of the first degree. Sugar of lead, lotions of alum water, camphor water, and other similar preparations have also been applied with success.



Vesication may be somewhat limited, even prevented, by investing the affected part with boracic lint soaked in cool boric lotion, this being covered with a number of layers of sterilized gauze or salicylic wool, the whole firmly applied by means of a bandage while the part being dressed is elevated so that the blood flows away from the wound. \* If blisters have already formed they should be pricked, the blood being allowed to escape and the epidermis being gently replaced. Zinc ointment answers well when the surface is not very large, and lead ointment has been used for the same purpose. While lead has been applauded by some authors it will be found very difficult of removal and is not a dressing to be recommended.

Calendula water is among the most desirable of all the dressings for burns from the second degree on. The succus calendula in sterilized water is soothing and sufficiently stimulating to promote healing. Where necessary to use an unction it should be impregnated with calendula. For this purpose lanoline is better than vaseline or cosmoline, which are sometimes irritating. Calendula oil is among the best dressings for burns and wounds following severe burns, where the recognized antiseptic methods are not practicable.

By preference, however, no matter what the degree of the burn, wounds of this character should be dressed antiseptically and the dressings be allowed to remain undisturbed as long as they continue sweet.

Exuberant granulations require the application of nitrate of silver or sulphate of copper, and if a considerable degree of raw surface remains, declining to heal, the application of a mild solution of nitrate of silver around the edges of the burn will stimulate granulation.

In burns of greater depth and those involving the deeper structures even the bones, general surgical principles will have to be observed. The thoroughly cooked tissues will have to be carefully dissected away, and as sloughs separate these too should be removed. Pus should not be allowed to gather and burroughs in the track of deep wounds, but must be promptly cleansed away in every instance by peroxide of hydrogen, this agent being followed by thorough antiseptic measures. Amputation of an individual part may be required, but this should never be resorted to except in rare instances until the patient has reacted from the severe shock, and until the line of demarcation between the burned and healthy tissue is clearly defined. Secondary amputation may have to be performed weeks or months after an injury, when it has been demonstrated that the reactive powers are not sufficient to thoroughly restore the structures or when it has been shown that the limb is so severely injured and deformed as to be a useless incumbrance.

Perfect rest is necessary for the promotion of healing in burn-wounds and for this purpose the patient must be put to bed and the burned surfaces rendered as immobile as possible by the proper application of dressings and straps with a view of preventing disturbance of granulating tissues.

**SKIN-GRAFTING.** Skin-grafting is required for the healing of large surfaces that fail to respond to other and simpler treatment. It is a tedious process and not always successful, but worthy of trial in every case of persisting raw surface and eminently gratifying when attended with success. It should be practiced under strict asepsis as described in the

section on Plastic Surgery. Grafts will not live upon a suppurating surface, and the longer the suppuration lasts the less likely is it to be successful. Sometimes when considerable islands of derma have been formed by this means and the case seems to be progressing satisfactorily these islands of new tissue will become infected from the suppuration going on, the cicatrizing area will break down and the whole process have to be repeated.

**CONTRACTURES.** Contractions are often rendered avoidable by the application of splints, which should be worn continuously until the case has fully recovered. Extension apparatus is sometimes necessary, especially where the burn involves the flexor muscles and tendons. Weights and pulleys will have to be brought into requisition in injuries of the lower limbs, and extension splints and elastic bands are frequently of use. In injuries of the palmar surfaces of the hand extension splints should be worn continuously until the fingers are thoroughly healed; otherwise contractions may occur that will render the hand useless. The surgical treatment of contractures is considered under the head of Plastic Surgery.

**Constitutional Treatment.**—Constitutional treatment will be directed at the time of the injury to securing reaction from the shock (See Treatment of Shock) and to overcoming the severe systemic symptoms that are at that time present. Consequently constitutional treatment will have to be directed toward relief of the pain which follows reaction, and, later, to the general support of the system as a guard against exhaustion. Constitutional measures will also have to be directed toward duodenal, brain, lung and kidney complications.

**TREATMENT OF SHOCK.** For the primary shock that follows upon burns or scalds it will be necessary to render the patient thoroughly warm as quickly as possible by the application of blankets, hot water bottles, and other local measures. Care must be exercised in applying heat not to produce local injury, it being borne in mind that the patient is at this time insensible to pain. Copious draughts of hot water, hot milk or other hot drinks that are acceptable will assist in overcoming the shock, and in occasional instances the free use of hot colon douches will accomplish an excellent purpose, just as the free application of hot water in abdominal surgery overcomes surgical shock. The first hours following severe burns may have to be spent in efforts at reviving the patient, no attention being paid to the local treatment of the injury. At this time the local administration, always in hot water, of the selected remedy, aconite, camphora, arnica, or veratrum album, will be necessary. Staphisagria is an excellent remedy for shock after severe abdominal burns. Hypericum will be required where trunks of nerve have been involved in the injury.

**TREATMENT OF PAIN.** The pain that occurs in Dupuytren's first three degrees of burns is generally the most prominent symptom that is to be combated unless the area injured be large and the shock profound. The pain is usually excruciating and of a burning character. Cantharis, terebinthina and aconite are excellent remedies with which to overcome it. They are to be preferred to the use of opiates, and where possible the selected symptomatic remedy should be applied in external lotion over moderate areas of burned integument. This combined internal and

external treatment will be found very advantageous. Hamamelis is a useful external lotion, it being sometimes sufficient to saturate sterilized gauze with a dilution of the tincture of hamamelis and bind this over the burned surface for the relief of the local pain.

If the suffering be severely constitutional general opiates may be required, but as a rule the selected homeopathic remedy is preferable.

**TREATMENT OF SUPPURATION.** The suppuration that attends deeper burns must be met by the local treatment already described, and by the internal administration of hepar sulphur and silicia as required. If offensive, and if sloughs remain attached, hepar sulphur will be useful. Silicia will be required in protracted suppuration, or where suppuration goes on to excess.

**GENERAL MEDICATION.** Aconite will be found especially beneficial immediately after the accident. It counteracts the nerve shock and modifies the intense anguish and fear. If there are general evidences of systemic shock, as extreme coldness, depression of the pulse, and mental hebetude aconite will not be required; but if the patient is intensely restless and is wildly fearful of dying from the injury, the pulse being hard, frequent and contracted, aconite will serve a better purpose than camphor or veratrum.

Cantharis is adapted to vesicular burns, and to superficial ulcerations. The pain of the injury is burning in character, and in children tetanic or mild epileptiform spasms are seen. If secondary vesication and erysipelatous inflammation occur at the site of the burn, cantharis will be found an excellent remedy.

Urtica urens is especially applicable to burns of the first degree, with intense burning, biting and formication of the skin. It may be given internally and also be applied locally in weak dilution of the tincture.

Asafetida is useful in burns and scalds in subjects who are exquisitely sensitive to pain. The child screams and is exquisitely sensitive to the application of dressings. This remedy is more useful for the mental terror than for the local injury.

Arnica meets the secondary inflammation of the skin and cellular tissues, and is applicable to the pain and nervous shock of severe and deep burns. If phlegmonous erysipelas follows the injury arnica is especially useful.

Rhus tox. serves a good purpose for scalds and burns with vesicles, bullæ and pustules. Vesication is extensive but not severe; the case manifests a tendency to a low vital state and sepsis. Rhus ranks with arsenicum, china, lachesis and other remedies for septic states of the system following burns and injuries, and with belladonna, arnica, apis and cantharis for erysipelas supervening upon burns and scalds.

Camphora and veratrum album will be found especially serviceable in the stage of shock. (See Treatment, Section on Shock.)



## SECTION VIII. GUNSHOT SURGERY.

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### CHAPTER I. VULNERATING BODIES.

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**Importance.**—The nature and treatment of gunshot injuries form a study of absorbing interest to the civil as well as to the military surgeon. Numbers of cases, the results of accident or the free use of firearms, come annually under the notice of the surgeon in civil practice. Numerous injuries also occur, resulting from explosions of one sort or another, which are of the same nature and require treatment upon the same principles as do gunshot injuries. The application of the methods of antiseptics to gunshot wounds has been followed by brilliant results in the limited number of cases in which it has been applied and enough field experience has been gained to show the possibilities of still greater success in the future. It is in times of peace in civil practice, where the details of antiseptics can be carried out, that the best methods of treatment are to be evolved and formulated. To the military surgeon is left the not small task of adapting these methods to the exigencies of field service.

**Definition.**—In a strict sense the term “gunshot wounds” is used to designate open injuries by missiles projected from firearms by the explosive force of gunpowder or similar material. The term gunshot injuries, however, covers all manner of injuries resulting from the impact of bodies deriving their impetus from the force of explosion. (Longmore.) The variety of form of the vulnerating bodies, the varying degrees of force with which they may be propelled, the differing degrees of resistance offered by the tissues of the body render the resulting lesions of all grades of severity, from simple injury to the skin by powder burn to the destruction of an extremity or an individual by large shot.

**Missiles.**—The missiles in use in the firearms of to-day vary in size from the small shot used by sportsmen to the shot of a ton in weight of the largest cannon; between these there are buckshot, pistol and rifle bullets, grape, canister, shrapnel, shells of various sizes and the solid shot, round or cylindro-conoidal, for cannon. Fragments of metal driven by the force of blasting or steam explosions inflict similar injuries.

**DIRECT AND INDIRECT.** The above are all classed as direct projectiles. As indirect projectiles are classed bodies which may be struck by direct projectiles in their course with sufficient force to convert them into missiles which produce injuries. To illustrate, it is enough to mention stones,

splinters of iron or wood, buttons or portions of accouterments, contents of pockets and an endless variety of other objects coming in the course of the direct projectile.

**Complications.**—Indirect projectiles may be the sole cause of lesion, but often enter the body with the direct projectile and in so doing complicate the injury. Healing of the wound is also frequently retarded and complicated by infection from portions of clothing carried into it by the missile. Burning of the skin from explosion of firearms at short range may produce serious complication.

**Classification of Gunshot Injuries.**—Gunshot injuries may all be classed as contused injuries with or without penetration. Under the head of non-penetrating come a large proportion of gunshot injuries of all grades of severity. Simple contusion of the skin may occur from the blow of a spent bullet. The impact of a spent ball over a superficial bone may produce deep contusion and secondary exfoliation of bone result.

**Non-Penetrating Injuries.**—Frightful effects are occasionally noted as produced by a large shot travelling at reduced momentum or striking a glancing blow upon the trunk or an extremity. A large shot striking the abdominal wall has been known to produce fatal injury by disorganization or rupture of the viscera, the skin remaining intact. The elasticity of the skin saves it from injury, while the underlying viscera, muscles or bones are reduced to pulp or fragments by the sudden compression. The impact of any blunt, heavy body moving at speed may produce similar injury. The author has seen a case of injury by a blow upon the right hip of a man who had been struck by a locomotive at high speed. The right half of the pelvis was a mass of osseous fragments and pulp of disorganized muscular and other tissues. The skin was unbroken save at one point where a spicule or bone had pierced it from within. A cannon ball, nearly spent and rolling along the ground no faster than a man could walk, has been known to inflict injury on the foot of a man trying to stop it of such a nature as to require amputation.

**Penetrating Gunshot Injuries.**—The effect of a solid shot of large size travelling with high velocity is to carry away all the tissues directly opposed to it. If an extremity be struck the resulting stump will be nearly even in its outline without retraction of the skin or muscles.

**LARGE SHOT.** The contusing effect extends for some distance above the wound surface, completely devitalizing the tissues. In these cases, as a rule, there is little hemorrhage. When such a missile travels at a lower rate of speed the injury produced is characterized by greater laceration of the soft parts and shattering of bone and more hemorrhage.

**GRAPE SHOT.** Grape shot produce wounds similar in character to those made by the larger solid shot, but less extensive and sometimes accompanied by lodgement of the ball.

**SHELLS.** Wounds inflicted by shell fragments, on account of the shape of the missile, are usually irregular in outline and severely lacerated. Lodgement of the fragment may occur from its striking the body at a right angle, but according to Longmore shell fragments ordinarily move in a line forming more or less of an acute angle with the part of the body wounded, and so the injury is rather superficial than deep.

**CANISTER AND SHRAPNEL.** Canister and Shrapnel inflict injuries by means of the spherical balls which they contain and also by the fragments produced by the bursting of the case, so that the characters of shot and shell wounds are combined.

**BUCKSHOT.** Buckshot, except when fired at short range, are very liable to deflection, or, striking squarely upon a bone, to flatten and become difficult of detection.

**SMALL SHOT.** Charges of buck or small shot fired at short range may enter the body in a lump and give the wound somewhat the appearance of having been made by a single projectile. The deeper soft parts in such a wound will be found much lacerated, and if the charge pass through the trunk or extremity the orifice of exit will be large and ragged. The effect upon bony structures will vary. If the bone opposed to the progress of the shot be of compact tissue much comminution will ensue. If a spongy bone be struck part of it may be carried away, but many of the shot will be lodged in the immediate neighborhood of the wound. Wounds by small shot at short range are particularly destructive in their effects upon tendons and nerves by laceration. By deflection of single grains important viscera or vessels, not in the direct line of the wound, may be injured. With greater ranges the distinct character of a central wound is lost and the charge is scattered over a larger area with less and less penetration as the distance is increased. Small shot wounds are more likely to be complicated by lodgement of fragments of clothing than are those made by single and larger projectiles.

**POWDER GRAINS.** As the result of explosion of gunpowder close to the body there may be lodgement of grains of powder in the skin. While not serious as regards loss of life or limb such cases require prompt and careful treatment to prevent the disfigurement likely to result from tattooing by the powder. Every grain imbedded in exposed portions of the body should be removed by a sharp, fine-pointed instrument as soon as possible after the reception of the injury.

**PISTOL BALLS.** A large part of the gunshot injuries met in civil practice are made by pistol bullets, generally of lead, cylindro-conoidal in shape and from .22 to .50 inch calibre. Occasionally these balls are hardened by the admixture of tin with the lead to insure penetration. Lately, also, some bullets are furnished having a central hollow about one-third the diameter of the ball and extending from the point nearly to the base; this effects a rapid expansion of the point of the ball on striking a hard substance, thereby doubling its calibre as it passes through the tissues. Except at short ranges the wounds made by most of the pistols in vogue are, on account of the small charge of powder, liable to great irregularity in their course, the missile being frequently deflected by meeting bone, tendon or fascia and likely to effect lodgement instead of perforation.

**RIFLE BALLS.** Bullets now in use in sporting and target rifles are generally made of lead with a small amount of some other harder metal, as tin, to harden the missile and increase its penetration. Those in ordinary use vary in calibre from .22 to .60. During the past twenty-five years great changes have been made in the military rifle and its projectile. From 1873 until recently the rifle used by the United States army was the Springfield model, firing a ball of 500 grains weight and .45 calibre,



with an initial velocity of 1,301 feet per second. The smallest calibre in use at that time by any other civilized nation was that of the Italian rifle, .40, with a ball of 308 grains and an initial velocity of 1,400 feet per second. In 1893 the leading European nations had adopted an average calibre of .30. The United States in 1893 adopted the Krag-Jorgensen model, calibre .30, firing a steel-jacketed ball of 220 grains weight with initial velocity of 2,000 feet per second and rotating 2,400 times a second on its own axis. The reduction in calibre of the military rifle came about gradually after the introduction of breech-loading weapons. A general belief prevailed that a rifle capable of great rapidity of fire and carrying a smaller bullet would result in the quicker disabling of greater numbers of combatants with less severe wounds than with the older weapons, and, therefore, on the ground of humanity the adoption of the rifles of smaller calibre was advocated. To insure rapidity of fire magazine rifles were introduced. The use of the ordinary black powder produced rapid fouling of the small bore. After much experimentation the so-called "smokeless" powder was produced in a practical form. This powder, being much more powerful than the black, gave greater initial velocity to the ball. To keep the ball straight on its course, it now being long and slender, a sharper twist was made in the rifling of the gun. This was found to "strip" the ball and lead the rifling, so to obviate this, in 1884, the mantled or jacketed ball was introduced.

The mantle or jacket varies considerably in its composition. German silver, copper, nickel and steel are all in use singly or in combination. Our war department has adopted a mantle of nickeled steel.

**EFFECTS.** When a rifle bullet traveling at high velocity strikes a bone in its passage through the body there are effects produced upon the osseous and surrounding soft parts similar to those of explosion; and writers on military surgery speak of "explosive effects." These are not to be confounded with the effects produced by explosive bullets proper which are used occasionally for the killing of large animals, and are in reality miniature shells. According to the terms of the Geneva convention such bullets are no longer used in the warfare of civilized nations. The explosive effects are produced by the impact at high velocity upon and shattering of the resisting bone by the projectile, the fragments acting as secondary missiles which, being carried forward and laterally, tear the soft parts and produce destruction of the tissues through a funnel-shaped area, the wider part of the funnel being at the wound of exit. This effect has been ascribed to "hydraulic pressure," and it is undoubtedly seen in its greatest intensity in enclosed moist tissues, as in the brain in the cranium. From experiments, however, it has been shown that the sudden arrest of a projectile in high velocity is accompanied by a lateral transmission of energy; e. g., if a ball be fired through a tin can filled with marbles the sides of the can show the impress in all directions of the contained marbles while the track of the ball through the can is of the characteristic funnel shape. It is evident that hydraulic pressure cuts no figure in this. The effect is increased also by the breaking up of the projectile into small pieces, each acting as an independent missile and widening the wound track in all directions. The sudden development of heat in the metal of the bullet by forcible impact, or acquired in the passage of the ball through the rifle barrel, has been held to be a factor in

the destructive effects as well as in the production of discoloration of the wound surfaces. It has been shown, however, that no sufficient degree of heat can be developed in this way to produce either the explosive or charring effect. A greater degree of heat than sixty-five degrees C. is developed only when a large number of consecutive shots are rapidly fired from the same piece. In passing through the body the projectile is heated to not more than sixty-five to ninety-five degrees C. The discoloration of tissues at wound of entrance is due to powder, lead-dust and lubricant wiped from the ball in its passage through the skin, and to ecchymosis in the derma.

It has been customary to classify the effects of bullets by the stages of flight into zones; as zone of explosive effects, zone of intense energy, zone of energy and zone of decreasing energy. It is impossible to make exact classification, for the effects shade into the various degrees gradually and are not uniform upon different tissues; thus while the explosive effects of the small-calibre jacketed projectile are said to extend to 400 to 500 meters, explosive effect has been seen in a wound of the liver at 2000 meters. In a general way it may be stated that in the range of highest velocity there is found extensive comminution of bone, great destruction of solid moist organs, clean cutting of blood-vessels, consequent, copious, primary hemorrhages and clean tubular wounds of muscles, also of lung when uncomplicated by impact upon bone. There is a general diminution in explosive effect corresponding to the lessening velocity, until within the zone of decreasing energy when lodgement of the projectile becomes frequent. The effect of the small-calibre jacketed projectile upon the contents of the abdominal cavity has been shown to be exceedingly severe, perforations of the intestines being accompanied by extensive laceration and loss of substance. In animals death ensues immediately from shock. In view of the evidence obtained up to the present time from reports of experiments, and the comparatively small amount of actual field experience with the new projectile, it must be concluded that, except in the cases of uncomplicated wounds of the soft parts or lungs, the so-called humane bullet is far more deadly and destructive than the projectile of twenty years ago.

## CHAPTER II.

### DIAGNOSTIC CONSIDERATIONS.

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**Diagnosis.**—Having considered the vulnerating bodies, it may be well to take up the general consideration of gun-shot injuries.

The history of the case leads at once to the inspection of the body of the patient for evidence of lesion. Persons bent upon suicide occasionally fire a bullet into the mouth or ear. Such cases, in many instances, do not end fatally, and there is often no external mark of violence. One well-authenticated case has been recorded of fatal result produced by the entrance of a ball per anum. (Otis.) An orifice of entrance being found further examination is made for an orifice of exit. The wound of entrance of a round ball is usually circular in shape, about the size of the ball itself, with discolored edges and often a general depression. Wounds made by conical balls vary much in appearance, occasionally slit-like, irregularly round or oval, rarely—by lateral impact of the ball—larger than the ball itself, and much lacerated. The margin is discolored and generally slightly sunken.

The existence of one or more openings having been determined, all further examination must be made only under the most absolute precautions possible against infection. On no account, save possibly the necessity for immediate digital compression of a wounded large vessel, should the wound be fingered without these precautions. The first handling of these wounds often decides their fate. Whenever practicable formal preparation of the region to be examined must be carried out. Before scrubbing or shaving the skin the wound should be filled with gauze to prevent surface dirt being washed into it. Examination of the wound may be necessary to check hemorrhage, to determine direction of wound, to locate and remove foreign bodies, more particularly splinters, extraneous objects, portions of clothing and the like, to determine extent of complications, as fractures, penetration of joint or other cavities, wounds of vessels or nerve trunks, to ascertain whether or not the missile has lodged and to remove it when readily practicable and necessary. Hemorrhage from small vessels may be satisfactorily met by compression, torsion or the ligature. Whenever arising from a large vessel exposure and ligation of the vessel in the wound itself is indicated. To meet this indication the wound should be opened freely, the edges retracted so as to obtain fair operating space and ligatures placed above and below the point of injury. If the vessel be not divided entirely by the injury it should be divided after the application of the ligature. To determine the direction of the wound is often a difficult matter. Following the well-established rule of placing the patient in the same position as that in which he received the injury may furnish reliable indication. The liability of round balls, pistol balls and other missiles at low velocity to be deflected by fascia, tendon or bone must be kept in mind. Otis reports a case wherein a



grapeshot one and one-fourth inches in diameter was deflected by the hyoid bone and buried itself in the muscles of the shoulder.

**Lodgement and Infection.**—Lodgement of the ball is inferred when only one wound is present, though occasionally no ball is to be found. A ball striking upon a superficial bone, particularly a rib, may rebound through the wound of entrance. A ball may carry a portion of clothing before it into the wound like a glove finger and be withdrawn with the clothing. The ball may fall out of the wound during the transit of the patient or may have been removed. As far as the ball itself is concerned it is as a rule best to make no prolonged search for it. The ball is not generally the infecting agent in the wound. Bacteriological tests have shown that over fifty per cent. of the bullets in cartridges in original packages are sterile (LaGarde). Examination of the clothing over the wound of entrance may show loss of substance and the probability of parts of it having been carried into the wound. Formerly the belief prevailed that portions of clothing, especially from that in contact with the skin, were heavily germ-laden. Experiments made by Pfuhl show that clothing taken from the bodies of soldiers from regions of supposed greatest uncleanness is singularly free from pyogenic germs. However, apart from the possibility of primary infection from shreds of clothing it is pretty thoroughly believed that the presence of cloth in a wound interferes sooner or later with its welfare, and, therefore, when found should be removed. This rule applies also to other extraneous bodies other than the ball, as splinters, etc. For the detection of foreign bodies and examination of the track of the ball the aseptic finger is the only reliable probe. It, and it only, can differentiate between the texture of cloth and the tissues by the sense of feeling. Probes have their use in determining the direction of a wound and otherwise, but for ascertaining its condition and contents nothing equals the finger. It is often the case, however, that the wound of entrance is too small to admit even the little finger. In such cases where thorough exploration is needful to settle questions as to extent of damage to bone, or of injury to joint or other cavity, the wound may, assuming of course that it be done under strict asepsis, be enlarged. Frequently the examination of the deeper parts of a wound is prevented by the smallness of the opening through the fascia. This may be slit-shaped, or much smaller than the remainder of the track of the bullet, and not admit of entrance of the finger or probe until enlarged. Digital examination of a wound in some situations is facilitated by counter pressure by the other hand so made as to bring the whole track of the wound within reach of the exploring finger.

If a probe be used it should be firm, of good size and capable of being bent to follow canals other than straight. When a hard body is found which cannot be clearly identified as bone or ball the surgeon may use the Nelaton probe, a firm staff carrying an oval tip of unglazed porcelain which on being brought into contact with a leaden bullet brings away on its surface a characteristic lead stain. An efficient substitute for the Nelaton probe is a piece of clean clay pipe stem first used in the Mexican war by Heighway. For the detection of bullets which have been lodged in the tissues for some time, rarely in the early diagnosis of gun-shot wounds, many ingenious electrical devices have been presented, most of them unreliable. The most useful of these is the telephone probe of Girdner as improved by Fowler. In this a telephone receiver is utilized so that

when a current is established by touching the ball with a probe insulated to the point a sharp click is conveyed to the ear of the surgeon. Surgeon Wells, United States navy, has still further improved upon the instrument by using a peculiar form of extractor as a probe, so that connection once established the ball is extracted without change of instrument. It may be mentioned also here that as long ago as 1869 the use of the endoscope was suggested by Fenger for the examination of the deeper parts of gunshot wounds. Practical application of the suggestion was made in the Franco-Prussian war.

When two orifices exist and are identified by their appearance as wounds of entrance and exit the inference is fair that the missile has perforated the involved part. If only one ball has struck and that ball has not split or been shattered upon a bone the inference is correct.

**Possibilities.**—Some possibilities are worthy of note. Two balls may enter, making one wound of entrance; one may lodge and one pass out. A single ball may make multiple openings, as when different parts of the body have been struck and perforated in succession. The author has seen a case in which the ball passed through the right thigh, the scrotum, and nearly through the left thigh, lying just under the skin on the outer side. In another case the ball passed through the left arm, the chest, and, entering the right arm, fractured the humerus and lodged. In each case five wounds existed. A ball may, after entering the body, split on the presenting edge, or a spinous process of bone, as the tibia, and produce wounds of exit, or one part of the ball may perforate while the other lodges. In the case of Col. G——, shot through the right shoulder at Atlanta, a perforating wound of the joint was noted; some small fragments of bone and cloth were removed, and recovery with fair use of the arm resulted. During the next ten years the patient suffered from several abscesses appearing successively lower and lower upon the back almost in a direct line downward until the author discovered and removed a fragment of minie-ball weighing about three hundred grains; with it was a small patch of woolen shirting. Wounds of exit are to be distinguished from those of entrance mainly by the general character of eversion. If the ball, travelling at high velocity, pass through soft tissues only the wound of exit may be only slightly larger than that of entrance. If the momentum of the ball be lessened by impact upon bone, then, as before stated, lateral extension of the wound occurs, with great laceration and a large wound of exit.

**Pain.**—The pain of a gun-shot wound has been variously described. Thus, in some cases, the patient has complained of a sensation as of a blow with a stick upon the part wounded. In others the sensation has been likened to that of rapid passage through the tissues of a hot substance or fluid. In cases of laceration of large nerves the pain may be intense from the first. Severe injuries with much destruction of tissue are often accompanied by slight pain, the parts being deadened as to sensation by the nature of the injury, or the shock of a severe wound may put the patient in an apathetic condition. The mental condition of the individual, that of intense excitement for example, at the time of injury may make him oblivious to the fact of his being wounded until reaction sets in. This is likely to be the case in flesh wounds. From the bruising of a nerve trunk, it being pushed aside by the missile without division,



the pain may be referred to distant parts supplied by that trunk. And, further, cases have been noted (Mitchell) in which the pain of a wound in an extremity was referred by the patient to the unwounded limb. Severe pain occasionally follows the impact of a spent ball upon the skin (bullet contusion) attributed by Longmore to the sudden, violent stretching of the parts which resist penetration as well as to the direct injury to the sentient nerves of the skin.

**Shock.**—With extensive injuries of viscera and of large bones and joints there is generally present an intense degree of the condition known as shock, characterized by surface pallor and coldness, depression of the circulation and respiration and anxious facial expression. Shock may follow upon injury instantaneously or may not be manifest for some time. Instances are recorded of men with severe wounds traveling considerable distances, being overcome by shock only after reaching a place of safety or coming under the care of the surgeon. Shock may be confounded with the depression of the system resulting from copious hemorrhage, and occasionally panic from a slight wound may produce a condition hard to distinguish from shock. The degree of shock in general is proportionate to the severity of the wound, but its duration in cases not primarily fatal from the injury is exceedingly variable, being influenced by the constitution of the patient, influence of surroundings and mental condition. Persistent shock when a ball has entered the body is to be looked upon as evidence of serious injury to vital organs, (Longmore.) Reaction from shock will be accompanied by an increase of the body heat, increase in strength of circulation and respiration, and improvement in color and mental condition. With the renewed vigor of the circulation hemorrhage may occur from vessels temporarily plugged during the depressed condition and must be watched for and treated according to indications.

**Hemorrhage.**—Wounds of arteries are often lacerated in character and followed by retraction of the coats and plugging. If an artery be struck fairly by a small-calibre projectile at high velocity it may be cut cleanly and copious primary hemorrhage ensue.

With the larger, softer missiles vessels are frequently pushed aside, often, however, with sufficient damage to their tunics to result in subsequent sloughing and secondary hemorrhage. All cases in which it is probable that a large vessel has lain directly in the track of a ball should be closely watched from the seventh to the twenty-first day and precaution be taken for immediate treatment should the emergency arise. Many instances are recorded (Longmore, Guthrie and others) where a ball has passed between a large artery and vein without opening either, but producing a sufficient amount of injury to lead to plugging and obliteration. Angular missiles, as fragments of shell, of stone, splinters, portions of buttons and similar sharp-edged or sharp-pointed objects, frequently divide vessels and cause free primary hemorrhage. Hemorrhage may occur beneath the fascia, forming traumatic aneurism, an outward flow of blood being prevented by the valve-like character of wound. Such cases must be treated by incision, evacuation of the clot and ligation of the artery on both sides of the injury.

It is impossible to arrive at anything like correct approximation of the number of deaths in actual warfare due to primary hemorrhage, for



the reason that reports are based upon the cases coming into the hands of the surgeon for treatment. Probably from twenty to forty per cent. of deaths upon the field of battle are due to primary hemorrhage.

**Secondary Disturbances.**—The secondary disturbances of gunshot injuries, the results of infection, need not be dwelt upon in this section. The recognition of these troubles will be made by the same signs and the treatment carried out upon the well-established lines adapted to infected wounds of other varieties.

**General Principles of Treatment.**—The general principles of treatment of gunshot injuries will be directed: *a*, to relieve pain and shock; *b*, to check hemorrhage; *c*, to removal of foreign bodies; *d*, to disinfection of wound; *e*, to antiseptic occlusive dressing.

**RELIEF OF PAIN AND SHOCK.** (*a*.) For the relief of pain and shock the methods in vogue in ordinary cases are indicated in gunshot injuries.

In cases where pain is predominant the hypodermic use of morphia answers a two-fold purpose—the relief of pain and cardiac stimulation. It may be necessary to make free use of stimulants by mouth, skin or rectum, and when needed it should not be done sparingly.

**HEMORRHAGE.** (*b*.) The treatment of hemorrhage has already been referred to, and here it is only necessary to add that in every case where possible every bleeding vessel should be definitively closed by ligature. Compression, flexion and constriction are to be regarded as adapted only for first aid and temporary dressing.

**REMOVAL OF FOREIGN BODIES.** (*c*.) Foreign bodies should be removed whenever practicable, but the probing and poking to which gunshot wounds are often subjected in civil practice cannot be too severely condemned. When inspection of the clothing shows loss of substance examination of the wound, invariably under rigid aseptic precautions, may be made to locate and remove it. Any foreign body localized by the aseptic finger or probe may be removed. For ordinary purposes a straight, strong forceps with well-serrated jaws will answer. For seizing and extracting a leaden ball well buried in the tissues the American bullet forceps. (Fig. 27) is as good as any. When possible the bullet should be grasped by the forceps so that its long axis corresponds to the long axis of the wound. The wound may need enlarging to permit extraction. Whenever a ball lies near the surface under unbroken integument it should be firmly grasped



Fig. 27.  
American Bullet  
Forceps.

and steadied with the thumb and finger of the left hand, while with the right the surgeon cuts freely over and down into the ball so as to thoroughly divide all strands of tissue which hold it in place. If a ball be partially imbedded in bone and resists extraction by ordinary instruments sequester forceps (Figs. 28 and 29) may be useful or the edges of the imprisoning bone may be cut away by the gauge sufficiently to release it. In a large proportion of cases, unless the removal of the ball be of easy accomplishment it may be left, and where one thorough exploration has

been made the wound should be dressed and no further primary interference allowed except under unusual circumstances.

**DISINFECTION.** (*d*) Disinfection is needed only in a small proportion of wounds, these complicated wounds. From what has been said it is obvious that only a few gunshot wounds are primarily infected and, therefore, the less a wound is meddled with the better for the patient. Simple wounds need no interior disinfection. Immediate sealing with an antiseptic dressing and expectant treatment has, so far, given the best results obtained in field practice. (Reyher, Von Bergmann, Langenbeck.) The experience of civil surgeons during the last ten years shows that the greater number of wounds by bullets of large as well as small calibre proceed to aseptic healing with no more disinfection than that of the integument about the opening or openings. It is believed by some authorities that an attempt at disinfection of the skin near the wound is attended by more risk to the patient than its omission. When disinfection is deemed necessary it should be made by free irrigation, without handling of the part. This may be supplemented in cases of complicating fracture by filling the wound with glycerine containing ten per cent. of iodoform. (Wagner.) In wounds of special regions drainage is of great use in preventing infection by giving vent to material which, pent up in the tissues, would afford a rich medium for the development of germs.

**DRESSINGS.** (*e*.) Doubts which pervaded many of our text-books from 1870-80 regarding the value of the antiseptic method in military surgery have been thoroughly dispelled during the last fifteen years by the reports from various wars and the numbers of cases successfully treated by civil surgeons. That a lessening of general mortality has taken place may be readily seen by comparing the death rate from wounds of the Franco-Prussian war, 12 per cent., with that of 1½ per cent. of the Servia-Bulgarian war. The ideal treatment of these wounds is primary aseptic or antiseptic occlusion, and where this is not wholly practicable every effort should be made to come as near to the ideal as possible.

Simple wounds should be dusted with iodoform, covered with liberal pads of gauze or cotton and allowed to remain undisturbed under the first dressing until healing has taken place, unless signs of infection necessitate inspection of the wound. Dressings should be voluminous enough to protect the wound from risk of infection from without, and the wounded part should invariably be immobilized during the healing process. Complicated wounds and wounds of special regions will require special methods of treatment, to be discussed later on. In cases which come under the notice of the surgeon only after infection has taken place, or when signs



Fig. 28.  
Van Buren's  
Sequestrum  
Forceps.



Fig. 29.  
Curved  
Sequestrum  
Forceps.

of infection appear some days after the first dressing, the most active measures must be taken to cut short the septic process. This will consist in making free openings by which the wound track may be disinfected by copious irrigation through every part of its extent and by the establishment of drainage. In the case of wound of an extremity amputation may be needed to save life. While active local treatment is carried on the patient must be sustained by feeding and stimulation and such remedies as may be indicated.

MEDICATION. In a general way the medication that goes with gunshot injuries is that that attends upon all surgical states. Shock will demand camphora, veratrum album, staphysagria, arsenicum, tabaccum, carbo vegetabilis and other remedies that experience has proven to be useful in shock and collapse, the main reliance being placed upon camphora and veratrum album.

As reaction comes on aconite may be indicated, especially if there be considerable rise in temperature, full, quick pulse, restlessness, thirst and other characteristic and well-known symptoms. Ferrum, veratrum viride, and gelsemium may also be required in occasional cases. These remedies and belladonna, opium, chamomilla, may be demanded for highly wrought states of the nervous system, it being always borne in mind that with many subjects fright is combined with suffering to produce shock and the after-symptoms belonging thereto.

Septic states of the system following upon gunshot wounds must be met by strictly modern surgical principles, and at times internal medication may be required in connection therewith. Here arsenicum, cinchona, rhus tox., baptisia, lachesis, kali phosphoricum, hepar and silicia may be studied to advantage.



### CHAPTER III.

## GUNSHOT INJURIES OF SPECIAL REGIONS.

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**Non-Penetrating Injuries of the Head.**—Non-penetrating injuries of the head, skull contusions, are in a considerable proportion of cases productive of serious results. Contusion of the scalp may be accompanied by sufficient damage to the underlying bone to produce osteitis and exfoliation, the latter occasionally including both tables of the skull. Concussion of the brain, generally present in severe cases of contusion, may follow even slight injuries. Intra-cranial suppuration may follow directly upon the injury, even as early as the end of the first week, but is more generally seen after the lapse of three or more weeks. This serious complication is commonly indicated by the sudden onset of intense cephalalgia, with convulsions, ending speedily, if unrelieved, in coma and death. Inflammation of the meninges, or brain, or both, of varying extent may follow contusion of the skull, and if recovery takes place the patient may for a long time suffer from symptoms of meningeal disturbance, derangement of the special senses, chronic headache and dizziness, all aggravated by exposure to heat or undue exertion. These symptoms may be relieved in time, but occasionally persist, the patient becoming subject to epilepsy or mental disturbances, even to insanity. Intra-cranial hemorrhage may result from contusion without penetrating wound of the scalp.

**TREATMENT.** The treatment of contusion of the head from gunshot will consist primarily in putting the patient at rest, and later in the treatment of symptoms as they arise. Symptoms of inflammation of the cranial contents should be met by the application of cold, either by the cold coil or ice-bags. Internal medication must be according to special conditions. Alcoholic stimulation should be used, if at all, only in the later stages of the case to meet an asthenic or septic condition. Careful attention must be given to the condition of the bowels and bladder. The former should be kept open and the latter regularly relieved by the catheter if necessary. Suppuration beneath the scalp must be treated by early incision and evacuation. If the pus be collected beneath the periosteum this must be freely opened and the exposed bone inspected for evidence of necrosis. If the bone be deprived of its vitality it should be removed by the chisel to such depth as may be necessary. This procedure may avert an extension of the infective process to the meninges. All operative interference must be conducted with the strictest precautions against sepsis. When signs of intra-cranial suppuration are marked, especially when the collection of pus is localized, the skull must be opened by chisel or trephine, and the pus evacuated with thorough disinfection and drainage. The success which has attended cerebral surgery leads us to advocate the opening of the cranium and incision of the dura to evacuate pus and relieve tension in diffuse suppuration. Furthermore,

the author believes it to be sound practice, if based on absolute asepsis, to relieve pressure and evacuate serum, and by so doing avert suppuration in the early stages of this class of cases.

**Penetrating Wounds of Scalp.**—Gunshot injuries of the scalp without accompanying osseous lesion may take the form of grooving, seton or contour wounds. Extensive loss of substance may arise from the impact of a large, ragged fragment of shell. A rifle ball at high velocity may inflict a wound closely resembling a clean cut. Lodgment is not likely to occur, except of balls traveling at low velocity. A small ball, as a buck shot, may flatten on the skull and be exceedingly difficult of detection. This is also the case if lodgement occurs beneath the temporal muscle.

**TREATMENT.** In penetrating scalp wounds thorough shaving and disinfection of the skin is the rule. Suppurating wounds of great length, subcutaneous channels, if presenting no evidence of contained foreign bodies may be sealed up at once after disinfecting and cleansing the skin about orifices of entrance and exit. Foreign bodies located in wound channels must be removed and the wound thoroughly disinfected. Rarely the wound may so closely resemble an incised wound that after disinfection it may be brought into partial or complete approximation by sutures, thereby shortening the duration of the process of healing. If drainage be deemed necessary it may be established by the introduction of a few strands of chromic gut. If there be considerable loss of substance of the scalp the wound, after being rendered as aseptic as possible, should be dressed with large pads of gauze until granulation is well established, when skin-grafting after the method of Thiersch should be employed for the repair of the deficiency.

**Penetrating Wounds of Head with Osseous Lesions.**—If the skull be hit by the modern projectile within the explosive zone we shall find thorough disorganization of the cranial contents and fearful comminution of the skull on the side of exit of the ball. These cases of course require no surgery. Direct blow by a large fragment of shell may produce extensive fracture of the skull in all directions from the point of impact. Fractures of the skull may be partial, limited to one table, or complete, in which the entire thickness of the skull is involved. Partial fractures affect principally the inner table, being of exceeding rarity in the outer wherein they occur at points where the skull is naturally thickened, as the mastoid process, the superciliary ridges, the occipital protuberance and the zygomatic process. A linear fissure in the outer table may be accompanied by fracture and depression of the inner table. The outer plate of the skull may be grooved or furrowed without injury to the inner plate. In perforating wounds of the skull the wound of entrance is generally smaller than the wound of exit. It is to be remembered that at the wound of entrance the inner table undergoes the most comminution, while at the wound of exit the outer table suffers most.

Extensive fissures may radiate from either opening without depression. The track of the wound generally will be found to contain small fragments of bone driven forward from the wound of entrance. The extent of fracture of the skull by fissuring can be judged in some cases by signs of the involvement of certain of the cranial nerves at a distance

from the wound of entrance. It is possible that penetration and lodgment may be affected by a ball without there being a visible opening. In such cases the missile has entered by a fissure, the outer contour of the skull being restored by the springing back into place of the temporarily depressed bone. Howard, U. S. A., reported the case of a soldier suffering apparently from a flesh wound of the left temporal and frontal region. The patient supposed that the ball inflicting the wound had been removed from beneath the integument of the forehead by another surgeon. The case was treated expectantly and did well for some days when symptoms of compression ensued and coma became almost complete. The bone was exposed by incision and found to be fractured, with moderate depression, but no opening was discovered through which a ball might be supposed to have entered the cranium. A single hair was noticed protruding from the line of fissure. Reasoning that the hair must have been carried in by some solid body, a portion of the bone was removed by the trephine and at the depth of about two inches from the fracture a deformed minie ball was found and extracted. The patient recovered and resumed service. (Longmore.) Hair has, however, been found in a fissure of the external table where no penetration had taken place. (Connor.)

Lodgment of the missile is inferred in cases of fracture with no wound of exit. As in other regions, however, the ball may have rebounded after exerting sufficient force upon the bone to produce fracture. The fact of lodgment can only be definitely ascertained by careful exploration of the bullet wound in the manner to be described later on. With the improved technique of cerebral surgery and the employment of modern antiseptic methods we may expect an improvement in the rate of mortality, which heretofore in penetrating gunshot injuries of the skull has ranged from sixty to ninety-five per cent. The danger to life increases with wounds of the base and posterior part of the skull. Complete perforation is less dangerous than penetration with permanent lodgment of the wounding body.

**TREATMENT.** The treatment of fractured skull from gunshot must be based upon the conditions present. Fracture with depression of bone, with or without signs of compression, must be treated by elevation and removal of detached fragments. Evidence of compression with or without external fracture should be met by the use of the chisel or trephine to open the cranium and remove the cause. Intra-cranial hemorrhage within operative reach requires cranial opening, evacuation of the clot and hemostasis. If localizing symptoms exist which do not correspond exactly to the site of the external injury the skull should be opened at the point of localization rather than under the injury. The conditions sometimes produced by a small ball—small external opening, fracture of the internal table and injury to the cranial contents (punctured fracture)—must be treated by enlargement of the opening, removal of fragments of bone and ball, if lodged, disinfection and drainage. If the fracture be linear without sign of depression the wound must be made aseptic, the patient put at rest and expectant treatment employed, the first evidence of intra-cranial trouble being met by prompt surgical interference according to indications. In penetrating injuries extending nearly through the whole of one dimension of the brain the best practice is to make a



counter opening and use through drainage. Fractures of the base of the skull, recognizable by the usual symptoms, must be treated by enlargement of the wound, disinfection and drainage. Communicating cavities, as the ear, nose or orbit, must be disinfected and packed with gauze. Drainage by puncture through cribiform plate of ethmoid may be needed. Absolute rest and quiet must be enjoined in all these cases, with strict attention to excretory functions.

**Removal of Foreign Bodies.**—Whenever a bullet or other foreign body is lodged within the skull an attempt should be made to remove it. Careful, thorough exploration should be made under aseptic conditions. The wound of entrance is usually circular and a trifle larger than the bullet. Just within the orifice of entrance will be found more or less fragments of the inner table. Room for manipulation may be gained by slightly enlarging the orifice of entrance. Examinations which necessitate any disturbance of the delicate brain tissue can be safely made only by the methodical use of Flushrer's gravity probe, or some similar instrument. Flushrer's probe is about twelve inches long, made of aluminium, with large conical ends. It is so light that by its own weight it will do no damage to the brain tissue. The proper method of use is as follows: After ascertaining the general direction of the wound the head is placed in such position as to make the supposed track of the wound vertical. The probe is allowed to pass downward into the wound channel by gravity until it reaches the ball. Measurement of the protruding end of the probe will show the depth of the ball when reached. Should the ball be found to lie nearer the opposite side of the skull than to the wound of entrance a counter-opening should be made and the end of the probe exposed by incision of the brain, if necessary. The point at which the counter-opening should be made is to be ascertained "by regarding the skull in various planes, first from above, then in front, etc., and following the line of the protruding part of the probe to the opposite side of the skull."

The depth of the ball from the counter-opening is ascertained by re-measurement of the protruding portion of the probe after it has been passed onward to the opposite side of the skull. Two strands of sterilized silk are now to be attached to the probe and drawn through the wound. By means of one of these silk threads a No. 9 French catheter, thoroughly disinfected and stiffened by the introduction of a straight stylet, is drawn through the wound to act as a guide in the extraction of the ball. A pair of forceps is now tethered to the catheter by a loop of silk attached to one of its arms and systematic search is made for the ball, above, below and at both sides of the guide. The search is made by successive introductions of the forceps rather than by sweeping them about the catheter. This detail is necessary to avoid injury of the brain substance (Keen). The ball being found and removed the remaining silk strand is used to draw a drainage tube through the wound. By counter-opening and search by this method Flushrer found and removed a bullet which had penetrated the forehead and brain and, striking the occiput, had rebounded into the brain substance. The case made a good recovery. The advantage of through and through drainage is well illustrated by a case under the care of the author about ten years ago. A young man was struck in the left eye with a pistol butt and knocked down. As he rose

from the ground his assailant shot him in the head. The bullet, 44 calibre, entered the skull in the left temporal region, an inch posteriorly to the edge of the orbit and about three-fourths of an inch above the zygomatic arch. The blow in the eye ruptured the eyeball. The bullet passed across the skull, shattering the left orbit, the cribriform plate of the ethmoid, and, after cutting the right optic nerve, made its exit through the right temporal bone and, fracturing the right zygomatic arch, glanced downward into the neck. The patient was unconscious and moaning. Examination showed the orifice of entrance, located as described, and protruding on the left cheek a mass of brain and bone fragments with the ruptured eyeball attached to it. From the nose issued a considerable flow of bloody serum with small particles of cerebral matter in it.

The first step taken was to cut down upon the fractured zygoma and to remove bone particles and cerebral substance from the wound beneath it. The mass of lacerated brain protruding from the left orbit was found to be almost detached and was clipped away with scissors. The orbital opening was cleaned with a one to forty carbolic lotion and packed with carbolic gauze. The nose was washed out as thoroughly as possible with the carbolic lotion and left open. It was perfectly easy to pass the index fingers through the skull until their tips met. A large rubber drainage tube was passed through the wound and a stream of the carbolic lotion run through until it came away clean. The head was then enveloped in many thicknesses of gauze. Large serous discharges followed for a week. The patient was more or less delirious for three days and had slight fever. His recovery from the wound was rapid. A year afterward he was in perfect bodily health, but blind and anosmic. There was no mental disturbance or diminution of intellect. The ball was traced behind the angle of the jaw and for some distance along the anterior edge of the sterno-mastoid muscle, but was never found.

**Hernia Cerebri.**—Protrusion from the skull of a tumor containing brain substance is properly termed hernia cerebri. It has been the custom to apply the term to any protrusion from the cranial cavity, but true hernia cerebri consists of cerebral tissue mixed with inflammatory products, and is due to pressure from within, from intense congestion, effusion of serum or abscess. Besides this condition we may have protrusion of a mass of exuberant granulations from the surface of the dura or the brain itself, this being more properly termed fungus cerebri. Various methods of treatment have been employed, mostly without success as to immediate results. Excision, incision, the ligature and compression have all been tried without any special benefit, and occasionally have been productive of mischief. If the protrusion be due to intra-cranial collection, as serum or pus, puncture with the aspirator needle may aid in diagnosis and evacuation. Antiseptic dressing, frequently changed and applied with a moderate amount of pressure, constitutes as useful a method of treatment as any. Hernia cerebri is most likely to follow wounds of the dura, which should, therefore, be sutured. Where there is an actual loss of substance of the dura it may be remedied by transplanting a piece of pericranium upside down and securing it by suture as suggested by Keen.

#### CHAPTER IV.

### GUNSHOT INJURIES OF SPECIAL REGIONS—CONTINUED.

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**Gunshot Injuries of the Face.**—Gunshot injuries of the face are frequent in civil and military practice, and are serious in result according to the nature and extent of complications. In these injuries life is endangered by hemorrhage—primary or secondary—and infection. The vascularity of the tissues involved makes free hemorrhage common, and if the lingual, facial or internal maxillary artery be wounded it may be profuse. Fracture of the upper or lower jaw may complicate the case, so also injury of the orbit or the antrum of Highmore. Extensive loss of substance, with great resulting deformity, may come from injury by large missiles or shell fragments. The eyeball may be entirely disorganized or rendered permanently useless by the lodgment within it of single shot or small bullet. Some years ago the bursting of percussion caps was a fruitful source of lodgment of foreign bodies in the eyeball.

Fractures of the lower jaw may be followed by much deformity and impairment of function, extensive loss of osseous substance being replaced by fibrous tissue. Injury to the upper jaw may be accompanied by great displacement of the jaw and neighboring bones. Salivary fistula is a frequent result of wound of Steno's duct. Wound of the tongue is likely to give rise to free hemorrhage and is also often complicated by the lodgment of bone splinters, teeth, or the ball itself. The facial nerve may be injured with serious after-effects from deformity due to paralysis. The tendency to deformity due to cicatricial contraction is great, frequently, in the case of the tongue, interfering with speech. Injury of the jaws is often followed by ankylosis, or want of correlation between the upper and lower teeth, interfering with mastication. The carrying away of the floor of the mouth may render deglutition difficult or impossible after cicatrization of the wound. Wounds of the face are often associated with head injuries by extension of the injury to the base of the skull.

**TREATMENT.** The treatment of these injuries consists, first, in securing hemostasis. This should, whenever practicable, be done directly in the wound itself. Often, however, the bleeding vessels cannot be reached; in such cases a gauze tamponade may answer. Whenever it becomes necessary to apply a ligature otherwise than in the wound an attempt should be made to expose and tie the branch immediately supplying the wounded part rather than the main trunk. The free side-to-side anastomosis existing between the vessels of the neck makes secondary hemorrhage common after ligature of a main trunk. The wound is next cleared of foreign bodies; all pieces of bone still attached must be preserved; only such pieces as are completely detached or denuded of periosteum should be removed. The most careful attention should be given to restoring the wounded parts to as near their normal position as possible. Depression of the nasal bones must be raised and kept in position by pads of gauze in the nasal cavities. Ordinary flesh wounds may, after



disinfection, be dressed with gauze strips saturated with iodoform colloidion (1 to 10). Several thicknesses of gauze strips may be applied so as to form an effective splint for the soft tissues and the thin, plate-like bones of the face itself. Much can be done by subsequent moulding by pressure, by finger or pads, to prevent deformity. With extensive loss of substance the ingenuity of the surgeon will be taxed to avert vicious contraction as the wound cicatrizes. In all cases where, by lodgment of foreign body or by direct destructive effect, the future use of the eye is lost, or where suppuration within the ball is inevitable, the eyeball should be removed early to avert extension of an inflammatory process to the other eye.

**Gunshot Injuries of the External Ear.**—These may be attended by no damage to hearing, but result in more or less deformity from loss of substance, giving small chance of repair by subsequent plastic surgery. The mastoid process may be fractured. The eustachian tube may be wounded and afterward closed by cicatricial tissue, as also the external meatus. Bullets or fragments of bullets lodged in the external canal must be removed. Buck records the case of a soldier wounded by two balls, one of which entered the skin just in front of the tragus and was removed three days later from beneath the skin just above the right eyebrow. Shortly afterward a comrade removed a lock of hair from the right ear. Discharge from the ear, occasionally bringing away small fragments of bone, was persistent, and after nearly ten years of suffering a ball was found in the external canal and removed. The second ball had been entirely overlooked by the first medical attendant. Lodgment occurs frequently from attempts at suicide with small calibre pistols. The author has seen one case in which after removal of a .22 calibre ball from the external auditory canal the patient recovered with only slight impairment of hearing. The bullet had been fired directly into the ear, and was found in two fragments.

**Wounds of the Tongue.**—These are apt to give rise to severe hemorrhage which may be successfully treated in many cases by deep suture; but when the laceration is extensive this may be impracticable. In such cases ligation of the lingual artery must be done. Tracheotomy may be needed to avert suffocation from acute glossitis. Phlegmon may develop in the substance of the wounded organ, and require treatment by free incision and disinfection. Very extensive shattering of the lower maxillary with loss of soft parts covering it may necessitate resection of part or the whole of the bone, but every effort should be made to save the bone to the patient by strict attention to antisepsis and careful adjustment of fragments. Wounds with slight loss of substance must be treated by disinfection and splinting according to established rules. Much may be done during the healing of wounds of the face to avert deformity and, later on, plastic surgery may be of much use in remedying some of the frightful distortions of the face produced by gunshot injuries.

**Wounds of the Neck.**—Wounds of the neck may be superficial and of slight importance or, on the other hand, may be followed by dire results from injury to the large vessels, the nerve trunks, the larynx, trachea or esophagus. In civil practice it is not uncommon to see pistol ball wounds of the neck, apparently involving the large vessels in their

course, do well under antiseptic occlusion without removal of the ball. Such instances, and many which have been recorded by military surgeons, owe recovery to the elasticity of most of the structures which belong to this region. While in warfare death in many cases has resulted from primary hemorrhage from wounds of the large vessels, instances are numerous in which, according to report, the old fashioned leaden bullet has passed between the carotid artery and internal jugular vein without damage to either.

Secondary hemorrhage, the result of sloughing of the bruised vascular walls, taking place ten days or more after injury, has caused death in many cases. With the thirty calibre jacketed bullet we may expect many more cases of death from primary hemorrhage from wounds of large vessels. According to the returns of the war of the rebellion wounds of the larynx and trachea occur in a trifle less than two per cent. of the whole number of the neck wounds. Thus of 4,789 cases of wounds of the cervical region, without known injury to the cervical spine, there were eighty-two of wounds of the larynx or trachea or both. The same table shows twenty-nine cases of wounds of the pharynx or esophagus or both. Wounds of the pharynx or esophagus were often fatal on the field from complicating wounds of large vessels or nerves. It is believed by some authorities that the trachea is capable of deflecting a ball. Where the leaden ball travelling at a low velocity is in question this belief may be correct, but with the new projectile perforation will occur, except at very long range. Following wounds of the larynx or trachea there may be exfoliation of cartilage; chronic cough and aphonia have been noted as after-effects. Rapid swelling of the larynx may occur soon after the injury or may suddenly appear some days later. Wounds of the muscles may result in deformity from cicatricial contraction or adhesions. Paralysis, partial or total, from injury to the cervical nerves or brachial plexus, has been observed in numerous cases. It may arise from direct cutting of the nerve, or from pressure by a lodged bullet or later from pressure by cicatricial tissue. Impairment of function may follow inflammatory exudation about a nerve. Infection of the wound may result in abscess which, unless evacuated early, is likely to make its way downward to the chest cavity.

**TREATMENT.** The arrest of hemorrhage in neck wounds is of primary importance. Bleeding vessels should be ligated above and below the point of injury. When it is an important branch of the external carotid that has been damaged, and cannot be duly tied on either side of the wound, the ligature should be placed upon the external carotid itself and not upon the common carotid—(Connor). Compression has been successful in wounds of the internal jugular vein, but the safer plan is ligation above and below the injury. Former apprehension as to the danger of cerebral congestion or apoplexy from ligation of the internal jugular vein has been shown by clinical experience to be groundless. Under antiseptic treatment a considerable proportion of neck wounds may be let alone, as far as search for the ball is concerned. If the missile be readily located, or its position be such as to render nerve trouble probable from pressure, it should be removed. Conditions of the larynx or trachea threatening suffocation must be met by prompt tracheotomy. Wounds of the pharynx or esophagus must be treated symptomatically. Feeding through a tube

passed beyond the wound may expedite healing, or if this be impossible, rectal feeding may be employed. Contraction of muscles during healing may be prevented to some extent by keeping the wounded muscle in extension during the process of cicatrization. Abscess must be evacuated early with disinfection and drainage.

**Injuries of the Spinal Column.**—Wounds of the spinal column are serious in proportion to presence or absence of injury to the cord itself, or its membranes. Serious complications may exist in associated wound of the thoracic or abdominal viscera, the latter being primarily or secondarily involved in the track of the bullet. Severe concussion of the cord may occur from the impact of a large non-penetrating missile upon the back. Fracture of the transverse or spinous processes may occur without penetration of the canal. Wound of the body of a vertebra is often accompanied by extensive fissuring and secondary implication thereby of the canal. Temporary functional derangement of the cord may be produced by contusion or concussion. Hemorrhages may take place within or external to the membranes, producing compression varying in extent and duration of consequences with the amount of clot. More or less impairment of function may persist from failure of absorption. Wounds of the spine and cord in military practice have been followed by high mortality. The analysis of 642 cases by Otis, noted during the war of the rebellion, shows that the higher the wound occurs in the spinal column the greater the mortality rate, being seventy per cent. for the cervical, 63.5 per cent. for the dorsal, and 45.5 per cent. for the lumbar region. From the brevity of the case-reports it is impossible to ascertain the proportion of deaths due solely to wound of the cord, or of those due to complications by other visceral wounds. Some of the high death rate may be attributed to infection, and under antiseptic treatment some lessening of mortality may be expected; but injuries of the cord must always be regarded as grave lesions. Cases recovering with life, are often subject to various degrees of paralysis, muscular atrophy, or loss of control of bladder or bowels.

**DIAGNOSIS.** The symptoms of injury of the spinal cord from gunshot are those common to injury from any cause. Generally shock is severe. The direction of the wound and escape of cerebro-spinal fluid may be important diagnostic points, although the latter may take place without actual injury to the cord. Immobility of the back, paralysis, anesthesia, hyperesthesia, girdling pains, sudden in onset and burning or gnawing in character, dysphagia, dyspnea, circulatory disturbances, constipation and retention of urine are all symptoms which may be noted. After a time bed sores are noticed and cystitis with incontinence of urine and feces.

**TREATMENT.** In the absence of positive symptoms of injury to the cord treatment will be expectant; loose fragments of bone may be removed, the wound made as aseptic as possible, and the spine immobilized. Immobilization may be best secured with the plaster of Paris jacket. To apply this the method of Dennis seems the most practical. The patient is fastened upon two stretchers placed end to end, the stretchers are then pulled apart and the dressing applied to the trunk in the space left by the separation of the stretchers. In injuries directly affecting the cord an exploratory operation may be done under strict antiseptic precautions.



By such procedure, compressing fragments of bone, blood clot, bullet or any foreign body may be removed. Such operation may involve opening the canal with the chisel. Clinical experience has shown that the longer the cord is allowed to remain compressed the greater and more complete is the resulting disorganization. Further, the operation of laminectomy adds little to the danger to life, if infection is avoided. After operation the spine must be put at absolute rest.

MEDICATION. Arnica should be prescribed for the shock to the general system, and hypericum for the shock to the nervous system and for injuries to the spine and large nerves. Aconite may be given with benefit as surgical reaction comes on. Gelsemium and belladonna are also to be thought of in this relation. Hypericum will be found most helpful in injuries of the cord, while aconite may be used with benefit during the inflammatory myelitis that follows. Opiates will usually not be required, but if the suffering is severe and not promptly relieved by other agents they may be demanded, their depressing effects upon the system being ever borne in mind.

As has been already stated, arsenicum, cinchona, kali phosphoricum and other remedies may be demanded for septic states following upon gunshot injuries, and this condition is very likely to follow upon such injuries of the spinal column unless the most rigid asepsis be practiced throughout the management of the case. Particles of bone, bullet, clothing, wound-debris or other foreign substance left in such a wound is almost certain to be followed by dangerous sepsis, hence the necessity for the most scrupulous care from the beginning of treatment. Symphytum is an excellent remedy for bone injuries, wherever found, and silicia, fluoric acid, hepar sulphur, and still other remedies may occasionally be prescribed with benefit in injuries to the spinal column, or cord, or both. All medicinal prescriptions will have to be made upon the general conditions and symptoms of the patient to be of value, but in occasional instances the special remedies named may be studied closely to no little advantage.

## CHAPTER V.

### GUNSHOT WOUNDS OF THE CHEST.

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**Statistics.**—From the time of Larrey to the present the proportion of wounds of the chest to the total number of wounded has been very nearly 1 to 12½, or eight per cent. The fatality, under modern methods of treatment, has been reduced from thirty to seventy-five per cent. under the old methods (Fischer) to ten per cent. (Gounzier). In military practice much difference in results will obtain in collecting statistics bearing upon this point, for the reason that in some engagements many cases come into the surgeon's hands which die quickly from hemorrhage. The more remote the dressing station from the scene of action the better statistical results will appear. Enough experience has been gained, however, to show that with aseptic or antiseptic methods rigidly applied the mortality of to-day in chest wounds may be reckoned at one-sixth to one-quarter of that of thirty years ago. The factor most potent in the ultimate result is infection. "Without infection most cases recover while with it most of them die, is amply proven by the results of pre-antiseptic times" (Gehrmann).

**Classification.**—The general classification of authors has been into penetrating and non-penetrating wounds. Under the latter are recognized:

Shot-blows, contusions, superficial wounds, or wounds confined to or involving only the soft parts, wounds of the bony walls.

Under penetrating wounds of the chest are placed: Penetrating wounds without injury of the viscera; penetrating wounds with injury of the viscera; a, of the lungs; b, of the heart, pericardium or great vessels.

**Commotio-Thoracica.**—Two distinct conditions result from contusions of the thorax from gunshot wounds. These conditions in practice should, whenever possible, be clearly separated from each other. There have been many cases observed of a condition of the thorax following contusion which was described first by LeGros Clark under the name of concussion of the lungs, in 1870, and by Meola, in 1879, as *Commotio-Thoracica*. Meola distinguishes two forms, the mild and severe. In the mild form the person injured makes first a deep inspiration, after that the breathing is quick and superficial, pallor, shivering and faintness supervene, and the pulse becomes small and intermittent. The symptoms are those of lowered blood pressure and last from minutes to days. Physical examination of the chest shows no sign of internal hemorrhage, but on auscultation feeble respiratory sounds and cardiac sounds, as if at a distance, will be heard. In the severe cases the patient falls as if struck by lightning, the heart and lungs stand still and death ensues at once. Experiments on animals by Meola, and also by Riedinger, show that these are cases of pulmonary shock, the lowering of the blood pressure being due to irritation of the intrathoracic vagus

and the sympathetic nerve ganglia. Post mortem examination of the fatal cases shows no lesion of the organs sufficient to cause death. The differential diagnosis of *commotio thoracica* from *contusio thoracica* is to be made on the presence of symptoms of profound shock and the absence of signs of wound of the thoracic viscera. In the cases not quickly fatal the prognosis is, as a rule, favorable.

**TREATMENT.** The treatment of *commotio thoracica* should be: Rest in the horizontal position, subcutaneous administrations of ether, strychnia or camphorated oil, and cutaneous irritation.

**Contusion of Chest.**—Contusions of the thorax vary in degree from the superficial to those accompanied by disorganization of the contained viscera. It has been frequently observed (Hamilton, Guthrie) that a soldier has received a blow upon the chest from a spent bullet—has even in some instances been knocked down by it—and though convinced from his sensations that the ball had entered the chest has returned to duty as soon as his fears were allayed, with no after consequences, or only those of a trivial nature. Again, the impact of a bullet on the chest, without perforation of the skin, has resulted in extensive subcutaneous extravasation, abscess beneath pectoral muscles, fracture of ribs, or has been followed by a localized pleuritis or pleuro-pneumonia. The degree of injury inflicted by a ball depends upon the direct force of the shot, its weight, and the amount of protection afforded the chest by the clothing, parts of the accoutrements, articles in the pockets, etc. Seydel cites a case of a soldier who was struck in the middle of the chest by a Chassepot bullet. The missile struck a leather pouch in which were three dollar pieces. The bullet was flattened on the coins, and received on its surface an impression of the inscription on one of the coins. After considerable pain and swelling at the site of injury the man recovered. Exfoliation of bone may occur as a consequence of shot contusion. Lidell says that any injury of bone in the nature of a bruise, however trivial it may appear at the time of infliction, may be followed by serious consequences, which it is the duty of the surgeon to anticipate or ward off if possible.

The effect upon the chest and its contents of the impact of a large missile moving slowly or striking obliquely is similar to that observed in cases in civil practice when a heavy body passes over the thorax, or the subject falls from a height or is caught between two solid bodies—i. e., on account of the elasticity of the chest walls the organs within are compressed to the point of rupture or laceration without wound of the outer coverings of the chest. These cases are largely fatal during the first twelve hours, from hemothorax, hemothorax or from ruptured lung, heart or great vessels; or, later, from inflammatory changes in the parts involved. The clinical picture is one of severe symptoms. Pallor, shivering, coldness of skin and extremities, quickened respiration, superficial or abdominal, great distress of patient from compression of lungs or heart by bleeding into pleural cavities or pericardium. Ashhurst has collected thirty-nine cases of injury of this sort, not due to gunshot wounds, however, of which only twelve recovered, and Otis has put upon record twenty-five cases with eleven recoveries. In warfare a large number of such cases undoubtedly die on the field. The mechanism of the injury has been pointed out by Gosselin as due to the glottis being closed at the moment of reception of the blow. The greater the expansion of the lung



and tightness of closure of the glottis the more probable will be a rupture of the thoracic viscera under sudden tension. A slowly increasing compression of the thorax may be made without causing serious injury to the viscera. Bouilly has made experiments on the cadaver which sustain the theory of Gosselin. (Riedinger.) It is noteworthy that the injury to the lung is not always found at the point of impact of the missile or vulnerating body, but often distant or on the opposite side. Besides rupture of the heart or lungs from *contusio thoracica* rupture of the esophagus may occur, with escape of contents into and suppuration of the posterior mediastinum. Further, the diaphragm may be ruptured, allowing the occurrence of a diaphragmatic hernia. Riedinger records a personal observation of a man who recovered from the thoracic injury, who, dying many years afterwards, was found to have sustained a rupture of the diaphragm through which part of the liver and some of the small intestines protruded into the thoracic cavity. This patient complained of no inconvenience from this condition during life. Cases of hernia of the lung through deficiency of the bony parietes, resulting from contusion, have been reported by Wahl, Weiss and others. LeGros Clark reports a case of hernia of the lung following *contusio thoracica*, the tumor appearing at point of displacement of rib from a blow on the chest. The tumor was at first of the size of two fists. Spontaneous recovery took place. Emphysema may occur from contusion. The cardiac valves may be lacerated by contusion of the chest, or the muscle be injured as in severe strain, predisposing to degenerative processes subsequently.

**TREATMENT.** In the milder cases of contusion of the thorax the treatment will consist of cold applications, compression by elastic bandage or bandage and wool, and, later, massage. In the severe cases of contusion of the thorax the conditions requiring immediate treatment are those which obtain in wound of the lung, and will be best met with rest, careful exhibition of anodynes, preferably morphia subcutaneously, and attention to hemorrhage. The treatment of the primary conditions which may accompany thoracic contusion—hemo- or pneumo-thorax, or both, and emphysema—will be practically the same as that in similar conditions in penetrating wounds of the chest and will be discussed under that head.

**Non-Penetrating Wounds.**—Superficial wounds of the chest, or those which involve only the soft parts, are mostly inflicted by grazing, grooving, seton and contour shots. These may involve the skin and subcutaneous tissue only, or may, without injury to the bony parts of the thorax, inflict severe damage upon the muscular tissues. As a famous instance of seton or contour shot may be mentioned the celebrated case of Dupuytren, where the bullet travelled entirely around the chest and made its exit at the wound of entrance. Comparatively large missiles have been known to travel under the integument for a considerable distance without producing more than temporary disturbance of the osseous structures. The mortality from these wounds in the war of the rebellion was only a trifle over one per cent. They are, as a rule, only slightly painful (Otis). These seton and contour wounds are often complicated by lodgment of foreign bodies, fragments of clothing or the wounding missile. Serious primary hemorrhage is seldom met with in the wounds under consideration, except in the infra-clavicular and axillary regions.

Here the surgeon often has to deal with injury of the subclavian or axillary artery or veins; these often cause rapidly forming, diffused traumatic aneurisms and blood tumors. Conner.)

Wounds of the bony walls of the chest without penetration of its cavity include shot injuries of the sternum, clavicle, ribs, scapula and vertebra. Fractures of the sternum without opening the pleura or pericardium are of rare occurrence. Often bullets, especially of small calibre, are imbedded in the bone substance; splitting and extensive shattering of the bone have been observed. Injuries of this bone, if not aseptic in course, may develop retro-sternal abscess, and, of course, this bone, like all others, is not exempt from exfoliation or necrosis after injury by missiles. The clavicles are liable to fracture but rarely in an uncomplicated form. Very rarely there has been observed a single transverse fracture; most often there is splintering of the bone, with sharp ends and fragments. The proximity of the large vessels renders them liable to implication. Shot wounds of the ribs occur as fissured, comminuted and transverse fractures, which are exceedingly prone to be followed by exfoliation and necrosis. Bullets have buried themselves in the ribs without shattering the bone, and in some cases the ball has been firmly wedged in an intercostal space, from whence, unextracted, it has made its way subsequently by ulcerative pressure into the pleural cavity. Fractures of the scapula are most frequently complicated with wounds of the thoracic cavity. The passage of a ball transversely may be followed by great displacement of the fragments through muscular action. Fracture of the neck, producing lowering of the shoulder, may appear like dislocation of the humerus. Extensive comminution of the bone is frequently observed. With fracture of the scapula there are often found free hemorrhages and frequently large extravasations beneath the bone.

**TREATMENT.** The treatment of non-penetrating wounds of the chest should be governed by the same rules as are applied to the treatment of wounds in general, the ideal in chest wounds being primary, aseptic or antiseptic occlusion. It is to be borne in mind that all interference with the wound is to be aseptic, and the risk of converting a non-penetrating into a penetrating wound of the chest should forbid any unnecessary probing. Whenever practicable, under strict antiseptic precautions, foreign bodies should be removed. Where these are engaged in a superficial wound the procedure is easy; but often lodgment occurs under thick muscular layers or under the scapula, sometimes rendering the discovery of lodged bodies exceedingly difficult, if not impossible. Sharp points of fractured bone that threaten puncture of the underlying pleura or pericardium should be cut off and all splinters removed as far as possible with safety to the patient, to prevent infection and remove sources of irritation.

Hemorrhage must be checked by ligation of the injured vessel in the wound itself, the wound being enlarged for that purpose if needful. If this fails ligation of the vessel should be made on the cardiac side of the injury. Styptics should be mentioned only to be condemned. Compression has been successful in many instances, but should be used only when the vessel cannot be reached or for lack of time for the necessary operative procedure. Wounds of the internal mammary artery may be secured in situ or by ligature in the second, third or fourth intercostal space;



below this, and sometimes in the fourth space, the artery can only be reached by resection of a costal cartilage. The intercostal arteries may be ligated in the wound itself, resection of a portion of rib may be made in order to reach it, or Agnew's procedure of casting a ligature around the rib may be practiced. Compression by Desault's purse may be tried when time may not be taken for a more radical procedure. A square of aseptic gauze is placed over the wound, its center pushed into the thoracic cavity and the pocket thus formed packed with small pieces of gauze until full, when by drawing the gauze forward pressure on the artery is made against the rib. A ligature is tied about the protruding gauze and secured by fastening over an external pad. Regarding injury of the axillary vessels Conner states that the exceedingly dangerous bleedings from the axillary vessels (those from the artery being much graver than those from the vein), which, though undoubtedly they have at times been stopped by compression, yet can be safely treated only by ligation at the seat of injury rather than above it, or by ligation followed by amputation of the whole upper extremity.

The wound being cleared of foreign bodies and hemorrhage definitely checked it should be converted as far as possible into the condition of an incised wound. Ragged edges should be pared or trimmed; in small wounds an elliptical incision may be made to remove the injured integument, the wound made aseptic, sutured in layers and dressed antiseptically. To facilitate healing of the wound (chest-wall wounds are slow in healing on account of movements of respiration) and to promote the comfort of the patient the thorax should be immobilized by plaster of Paris bandage. Fractures after antiseptic treatment of the compounding wound, according to the foregoing suggestions, should be dressed according to established rules. It would be desirable to make the first bandages temporary until the progress of the wound can be noted, and then a permanent fracture-dressing made by application of water glass, or plaster of Paris over the first.

**Penetrating Wounds.**—Penetrating wounds of the chest without injury of the thoracic viscera are seen occasionally. The intimate contact of the pulmonary and costal pleura makes such wounds exceedingly rare. Grazing and contour shots which strike the thorax at a tangent may run under the intercostal muscles and open the costal pleura without involving the pulmonary pleura or the lung substance. Opening of the pleura may be caused by a bone splinter carried in advance of the ball or by the ball itself. The ball sometimes remains sticking in the wound and falls into the pleural cavity. The exact diagnosis of these injuries is attended with much difficulty. Some information is to be obtained generally from examination of the wound. Traumatopnea, the to-and-fro passage of air through the wound, the expulsion of foamy sanguineous discharge during expiration, and emphysema of the skin surrounding the wound indicate opening of the pleura.

Pneumothorax, evinced by amphoric resonance, absence of vocal fremitus, expansion of the chest wall, fullness of the intercostal spaces and dyspnea is a frequent but not constant effect of penetration of the pleural cavity. The non-appearance of pneumothorax is, however, according to Koenig, not proof that the pleura has not been opened. The wound, although penetrating, may have been closed by the alteration in



position of the muscular layers through which it passes. The thicker the muscles the more likely is this to have taken place. Pathological conditions, as pleural adhesions, may make the formation of a pneumothorax impossible. Hemothorax shown by dullness on percussion, absence of lung sounds, fullness of intercostal spaces, dyspnea from compression and displacement of heart and lung, and the symptoms of internal hemorrhage may occur from hemorrhage into the pleural cavity from the internal mammary or intercostal artery. It has happened from a small wound of the subclavian vein. Pneumo-hemothorax may be present and recognizable by dullness on percussion of the dependent portion of the pleural cavity and increased resonance of the upper portion. Metallic tinkling and absence of respiratory sounds will be noticed. Distress in breathing will correspond to the amount of compression of the heart and lungs.

**Wounds of the Pericardium.**—Penetrating wounds of the pericardium have been observed without wound of the heart. These give rise to pneumo- or hemo-pericardium. So-called hernia or prolapse of the lung through the open wound is rarely seen, as the lung more often collapses.

Most penetrating wounds of the chest are complicated by wounds of the contained viscera. Frequently, even when an opening has actually been made in the chest wall, diagnosis as to visceral wound is rendered obscure by many conditions as, e. g., when the missile is small and has entered obliquely, or when from change of position of the patient the parallelism of the wound through the different layers of tissues is changed, or the ball may have entered through the thick muscles of the shoulder and dorsal region or through the scapula. The presence of two wounds, entrance and exit, does not prove the perforation of the chest, for the case may be one of seton or contour wound. Hemoptysis may occur from all grades of contusion, and also in many cases where there is no direct injury of the lung. Severe shock may be present without wound of the lung, and, further, may be absent when the lung is penetrated or perforated. Free external hemorrhage, or internal, forming hemothorax, may come from an internal mammary or intercostal artery. Emphysema, much more frequent in stab than bullet wounds, may come from air inspired through wound of entrance; so also pneumothorax and traumatopnea. Lumbar ecchymosis, held by Valentina and Larry to be a trustworthy sign of hemothorax, is thus disposed of by Legonuest: "This symptom is without importance, and its appearance, always late, adds nothing to the diagnosis." Pain is not always severe; frequently very slight. Cough, occasionally very harassing, is not so frequent as might be supposed. In addition to the physical evidence obtainable by sight, touch and hearing, we must consider the aggregate of signs of wounded lung, which, as before said, are by no means constant or always present. These are shock, collapse, faintness, dyspnea, hemoptysis, foamy expectorations, hemo or pneumothorax, traumatopnea and emphysema. Connor states that "Early and persistent marked reduction of temperature furnishes strong presumptive evidence of visceral lesion." Injury of the heart or pericardium is rendered probable by quick-appearing great shock and precordial oppression, with succeeding pericarditis or endocarditis (Connor). Physical examination of the chest gives reliable information as to the existence of pneumothorax, hemothorax or pneumo-hemothorax,

A knowledge of the position of the patient at the time of reception of the injury may be of service in judging the probable course of the missile. Examination of the clothing over the wound of entrance should be made to ascertain possibility of lodgment of portions of the materials in the wound. Wounds of the lung increase in gravity as they near the root. Perforation of the edge of the lung may occur without giving rise to any positive symptoms. Central injuries give rise to quickly fatal hemorrhage in many instances. Habart reports that the new rifle bullets of small calibre inflict small, smooth-walled wounds of the lung tissue, narrow and hard to trace, and prone to severe after-hemorrhage. Otis doubts the occurrence of recovery after a case of perforating wound of both lungs, but cases have been reported by Fischer and Sommerbrodt where post mortem section made years after the reception of the injury showed that both lungs had been simultaneously wounded. Wounds of the heart and great vessels are, in the majority of cases, speedily fatal from primary hemorrhage. Some cases live for some time, however, hours to days, and rarely a shot wound of the heart is followed by recovery. Thus Hamilton says: "I have in my possession the heart of a man named John Kelly, containing a round musket ball which lies encysted in the apex of the right ventricle, and which was received twenty years before his death. There is conclusive evidence that during the first five years it lay near the right jugular vein, and that, having at length made its way through the coats of the vein, it dropped into the ventricle, and finally became imbedded in the walls of the heart at its apex. It remained in the heart there for fifteen years, and was not then the immediate cause of his death." Fischer has collected four hundred and one cases with fifty recoveries; the diagnosis in thirty-three of the latter having been verified by post mortem section. The symptoms of heart wound are shock, precordial distress, cold sweat, pallor, small and intermittent pulse, cardiac dullness increased in area and intensity and proof of hemopericardium. Heart sounds are diminished in intensity, as likewise the cardiac impulse. Asystolic bellows murmur is the most usual abnormal murmur observed in cases of heart wound (Ashhurst). These symptoms are not constant. The position of the wound directly over the organ is not proof that it is injured. The author has seen two cases in which the heart was apparently directly in the track of the ball, but no sign existed of cardiac injury. Wounds of the pericardium are particularly dangerous through danger of compression of the heart by pneumo-or hemo-pericardium.

The essential treatment in cases of this kind, after checking hemorrhages from all sources outside the thoracic cavity, removal of foreign bodies, when within easy reach, as previously advised, and antiseptic cleansing of wound, is to secure primary antiseptic occlusion of the wound. Foreign bodies are not to be sought for in the lung substance. Bullets may become encysted, or, in the event of irritation arising from their presence, may be dealt with later. Prolapse of the lung should be replaced, when possible, by enlarging the wound for that purpose. It must be remembered that pneumothorax may be produced by replacement of the prolapse. The prolapsed portion of lung having been made aseptic should be replaced under a large piece of protective, so as to



prevent aspiration of air into the pleural cavity. If reduction be impossible it should be covered with large antiseptic compress to promote aseptic necrosis and off-casting of exposed portion. Guthrie speaks of the three cases doing well under simple dressing—cold water compress, and advises non-interference. Up to 1870, according to Otis, only one successful case of replacement had been reported—that of Angelo. Riedinger has collected four cases, in all of which the replacement was successful. Ligature of the prolapsus has been practiced, but was followed in one case by tetanus (Kirchoff). The tetanus was relieved by loosening the ligature. Having closed the wound the next care is for complications. Pneumothorax, unless producing dangerous compression of viscera, may be left alone, being as a rule quickly disposed of by absorption of the air. If it exert too much pressure it should be relieved by puncture, preferably aspiration.

Emphysema, unless very extensive, may be confidently expected to disappear under the compression of the dressing. If of large extent multiple punctures may be made. All penetrating chest wounds should be carefully watched for hemorrhage. Temporary hemostasis may be brought about by circular compression of the chest walls to limit respiratory movements. Hemothorax of small or even quite large extent may be absorbed by the pleura, or after some days, when occlusion of the bleeding pulmonary vessels by thrombosis has taken place, the blood may be removed by puncture under aseptic precautions.

What shall be done for cases of hemothorax threatening life by compression of heart and lungs as well as by hemorrhage? Up to the time of the Crimean war venesection was universally practiced in chest wounds, first to produce hemostasis, and, second, to avert inflammation. During the Crimean war the practice was abandoned by many surgeons, and has had only slight support since. Fischer recommends it in exceptional cases of great dyspnea and cyanosis when other means fail. The general rule of practice in hemothorax threatening death by compression now is, under aseptic methods, by puncture, incision, or resection of rib to evacuate enough of the contained blood to relieve symptoms, and close puncture, letting the patient lie upon the wounded side.

Von Lesser contends that after having learned from the results of antiseptic wound treatment that the dangers in opening large body cavities lie elsewhere than in the mere exposure to air it will be the task of the future to conceive and try a direct hemostasis in pulmonary hemorrhages, if possible, under the protection of antiseptics, after the affected part of the thorax has been laid open. For cases of slowly increasing hemothorax the plan suggested by Rushton Parker deserves further trial. This consists in the conversion of the hemothorax into a pneumo-thorax by the injection into the pleural cavity of air, sterilized by being forced through a carbolized solution in a Wulff's bottle. It produces compression of the bleeding lung without the loss of blood to the patient, and may be done through the aspirator needle. In severe cases of hemoptysis hemostasis has been produced by shutting off from the general circulation the blood contained in the extremities by constricting bands applied near the trunk, thereby producing syncope, after which the blood in the extremities is gradually returned to the heart by loosening the bands at intervals. This procedure might be of service in growing hemothorax. In cases where



pleural adhesions fix the lung to the chest wall, if such condition could be definitely ascertained, gauze tamponnade of the lung wound might be used. Hemo-pericardium must be treated by evacuation of the pericardium by operation or enlargement of wound whenever paralysis of the heart is threatened. The experiments of Block on animals lead to the hope that suture of the heart wall may yet be successfully practiced on the human subject. Suture of the pericardium itself has been successfully done. In wounds low down in thorax, where probability of perforation of diaphragm exists, a portion of a rib or ribs may be resected and subjacent viscera inspected. The wound in the diaphragm may be enlarged for this purpose. For the treatment of the visceral wounds, should such be found, a laparotomy may be done directly below the costal margin to obtain ready access to the lesion. Dalton, of St. Louis, has reported successful cases in which this method was followed. The patient suffering from a penetrating wound of the chest should be treated by absolute rest and cooling drinks should be administered, or small pieces of ice to allay thirst. The application of cold to the chest surface is not often a practical measure, as the cold will not be effective through such a dressing as should be primarily applied. This should be liberally thick. Of the drugs which have been recommended in chest wounds nothing calms the patient, eases pain, and has a better effect upon the hemorrhage than morphia given by hypodermic injection. Ergotine administered in the same way may be of service in hemorrhage. Digitalis may be needed to strengthen a heart failing from acute anemia. Alcohol in any form should be cautiously used for fear of excitement of the circulation. The diet should be liquid and sparing.

Dennis urges strongly the continuous drainage of the bladder by perineal cystotomy, as practiced by Harrison in cases of fractured spine. The urine is carried from the bladder through the tube to a vessel upon the floor. Two sets of tubes should be employed; each set after being in use for twenty-four hours should be washed in hydrochloric acid and kept in bichloride solution until used again. By such means, with frequent antiseptic irrigations of the bladder, cystitis and its frequent sequel, pyelitis, may be avoided. The patient is kept dry and thus the formation of bed-sores is to a considerable extent prevented.

## CHAPTER VI.

### GUNSHOT INJURIES OF THE ABDOMEN.

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**Non-Penetrating Wounds.**—Contusions of the abdomen may be of all grades of severity, from superficial injury produced by the impact of a spent ball or one of initial low velocity, to the destructive effects on the viscera of the blow of non-penetrating heavy missiles. The blow of a large round shot has been observed quite frequently to produce laceration or rupture of the hollow viscera, or complete disorganization of the solid organs without penetration.

Wounds of the abdominal parietes without penetration of the cavity occur as grazing, grooving or seton wounds, or a ball may lodge after travelling a greater or less distance in the tissues. Wound of the kidney, colon or bladder may occur without peritoneal perforation. Severe laceration of muscles may occur and large extravasations result from injury to vessels in the abdominal wall. Extensive destruction of muscular tissue is likely to be followed by weakening of the wall, resulting eventually in neutral hernia. On the other hand, cicatricial contraction may follow lacerated wounds of the parietes and produce deformity and disability.

**TREATMENT.** Simple contusions of the abdominal wall without visceral lesion may be satisfactorily treated by rest, and compression of the contused area by pads of absorbent wool under a circular bandage. When contusing injuries of the abdomen are accompanied by profound shock subnormal temperature, signs of internal hemorrhage, progressive acute anemia, with physical signs of collection of fluid in abdominal cavity, or sudden tympanites, the rational inference is that serious lesion of the contained viscera has taken place. Such a condition being diagnosticated calls for immediate laparotomy and treatment of lesions found, according to their nature. Wounds of the abdominal wall without penetration of the cavity must be treated by hemostasis, if necessary by direct ligation, removal of foreign bodies and antiseptic dressing. The wounded part must be put at rest by immobilizing dressing.

**Penetrating Wounds.**—The abdominal cavity may be penetrated by a bullet or even traversed without injury to the contained viscera. This has been noted most frequently when the direction of the ball has been antero-posterior and the wound above the umbilicus. Senn found in four out of fourteen experiments upon the cadaver that the ball entering the upper half of the abdomen had passed through the cavity from wall to wall without serious injury to the viscera. Clinical experience has shown that in a certain proportion of cases of antero-posterior direction of the bullet through the upper half of the abdomen no injury of the viscera requiring interference has occurred. It must be borne in mind, however, that in more than three-fourths of the cases of penetrating wound of this region perforation of the gastro-intestinal canal or wound of the liver, spleen or kidney is probable. Martin and Hare conclude "that penetrating gunshot wounds of the abdomen wound the contained viscera

in over ninety-five per cent. of cases, in sixty-five per cent. of all cases the small intestines being involved." The greatest number of perforations of the intestines, sometimes twenty or more, have been observed in side-to-side or oblique wounds of the abdomen below the umbilicus. The perforation in the bowel may vary from a circular opening of about the size of the vulnerating ball to a ragged laceration of considerable extent. The size of the perforation with the ordinary bullet will depend upon the angle at which the missile strikes the intestine. Perforation by small calibre bullets may be closed by eversion of the mucous membrane. Wounds affecting the descending colon or sigmoid flexure may recover with or without the formation of fecal fistula. Perforations of the small intestines, without surgical interference, are almost uniformly fatal. The effect of the modern, small-calibre jacketed projectile upon the abdominal viscera is peculiarly destructive. The solid organs are pulped at short ranges, and even at 2,000 metres show evidence of explosive action. The hollow viscera are torn to pieces at short range and at longer ranges undergo such extensive laceration that surgical interference will be of little or no use. Many cases die of primary hemorrhage from wound of the omental or mesenteric vessels, or of the solid organs.

**Diagnosis.**—In all cases of abdominal wound, save the most superficial, the surgeon is confronted by the question of penetration or non-penetration. In the absence of protrusion of some portion of the abdominal contents, or escape of bile or gastro-intestinal contents through the wound, no symptoms are found except those pertaining to internal hemorrhage which can be relied upon. These latter are, extreme pallor, dilated pupils, feeble and rapid cardiac action, with the physical signs of accumulating fluid in the peritoneal cavity. Shock and gastric disturbance may be present in comparatively slight contusions, and may be absent in penetrating wound with multiple perforations of the intestines. Pain is so variable in degree as to be unreliable as a diagnostic symptom. Subnormal temperature, when present, is indicative of serious injury, but may not appear for some hours after the receipt of injury. Discharges of blood from the stomach or bowels appear often as the result of contusion and may not be present in penetrating wounds, or may appear too late for use in immediate diagnosis. In cases of doubt as to the penetration of the abdominal cavity careful laying open of the wound should be practiced to determine the question of penetration. In all cases, where practicable, before resorting to surgical procedure the stomach of the patient, unless empty, should be cleared by siphon or an emetic of salt and water. The rectum should also be evacuated by enema before the patient is anesthetized. Such exploration must be made with the utmost care to avoid converting a non-penetrating into a peritoneal wound, and under the strictest antiseptic precautions. The operator must be fully prepared to deal with any lesion discovered in the operation.

"The track made by the bullet must be followed by enlarging the wound, by an incision at least two inches in length, which should intersect the perforation where its diameter is greatest and in the direction of the principal muscle involved by the perforation. It is not often an easy task to follow the track of a bullet with the scalpel through a thick abdominal wall. The best method of procedure is to insert a grooved director as far as it will pass without resistance, and then to divide the



tissues layer after layer, catching bleeding vessels with hemostatic forceps as fast as they are cut, in order to keep the field of operation as nearly as possible in a bloodless condition. The divided tissues are held out of the way by sharp toothed retractors, in order to enable the operator to follow the course of the bullet with his eye as well as with his instruments. When the point of the director is reached it becomes necessary to make a close inspection, and under no condition should the knife be used until the wound canal can again be identified and followed with the eye or the director. The dissection is to be made carefully and slowly until the opening in the parietal peritoneum is reached which completes the first part of the diagnosis" (Senn). The dissection having demonstrated the existence of a wound in the parietal peritoneum the next step will be the determination of the extent of injury to the underlying viscera. In 1888 the attention of the profession was called to the use of rectal insufflation of hydrogen gas by Senn, of Chicago. It has been successfully used in many instances and whenever obtainable will be found to save time in locating perforations. After the rectum has been emptied by enema it is possible to pass the gas through the entire length of the alimentary canal. If the bowel fails to inflate by reason of perforations the gas will escape through the exposed parietal wound. If, on the contrary, the gas passes the whole length of the canal it is evident that the alimentary tube is intact. The gas is used through a rectal tip connected by rubber tubing with a rubber balloon containing two to four gallons of pure hydrogen gas. The tip is held securely in the anus to prevent escape of the gas while pressure is made upon the balloon. If the wound be in the upper segment of the abdomen the stomach may be inflated through the ordinary stomach tube. In the absence of the hydrogen gas apparatus air may be used for insufflation. Unless the gas or air insufflation be used the surgeon will be compelled to examine the intestinal tract, or at least the full extent of gut likely to be involved in the injury, inch by inch, necessitating a great loss of time and exposure of the intestine, both militating against the success of the operation.

Fatal results come about in cases of penetrating wounds of the abdominal cavity from shock, hemorrhage and infection, the latter resulting from extravasation of the contents of the gastro-intestinal canal or from without, through instruments or fingers.

**Treatment.**—If the exploratory incision above described shows the wound to be non-penetrating the treatment will consist of dissecting out the track of the bullet and suture of the abdominal wall, if time permits, in layers. The same course may be followed in penetrating wounds without visceral injury. Antiseptic precautions thoroughly carried out will generally secure union by first intention. Indications of hemorrhage into the abdominal cavity call for immediate laparotomy and securing hemostasis. To check hemorrhage during transportation of the patient, or while preparations are made for operation, pressure should be made over the abdomen by means of a firm, large pad and binder. Circular constriction of the extremities close to the body may also be practiced as a blood-saving measure. For this purpose the incision should be free and in the median line over the involved area. Free hemorrhage may be checked sufficiently long to locate its source by compression of the aorta

below the diaphragm. This can be effected by the hand of an assistant in the upper end of the incision, which may have to be enlarged for the purpose. Packing the cavity with sponges or gauze compresses may be necessary to check parenchymatous hemorrhage. The compresses may be removed from below upward and bleeding points secured by fine silk ligature as they are found. Wounded mesenteric vessels should be encircled by an aneurism needle armed with the ligature and tied en masse. Wounds of the liver giving rise to hemorrhage may be treated by suture, gauze tampons or the actual cautery. Sutures in the liver should be placed well away from the wound edges, at least an inch, and tied just tightly enough to put wound surfaces in opposition. Extensive wounds of the spleen with much laceration and disorganization of its substance can be dealt with only by removal of the organ. Tamponnade with aseptic gauze may answer in slighter injuries. Wounds of the pancreas, if giving rise to hemorrhage, should be treated by the aseptic tampon. Serious disorganization of the kidney by gunshot may call for immediate nephrectomy, partial or total.

If the nephrectomy be made through the abdominal incision lumbar drainage should be established and the peritoneum closed. Hemorrhage from the kidney, unless accompanied by such disorganization as to necessitate partial or total nephrectomy, may be dealt with by suture or the aseptic tampon. Extra peritoneal lesion of the kidneys may be treated by lumbar incision and drainage for the slighter injuries, or by partial or total nephrectomy for destructive laceration. In all cases of intra-peritoneal hemorrhage the first care of the surgeon will be to find and secure bleeding vessels. Hemostasis being accomplished, perforations of the intestinal canal are to be sought for and treated. If gas or air be used time is saved and the perforations much more easily and certainly located than by touch or sight. The lowest perforation having been found by rectal insufflation the rectal tip is changed for one that is aseptic, and inflation made through the perforation itself to locate the next above. The first perforation being closed by suture the process is repeated until all the perforations are closed. If the stomach be wounded the inflation is made through a stomach tube, and should be repeated after suture of the opening or openings which have been discovered, not only to test the efficacy of the suture but to reveal the existence of other perforations. One case has been reported in which one bullet produced these openings in the stomach. Two of these were readily found and closed by the attending surgeon. The patient dying of septic peritonitis the autopsy revealed a third opening which had escaped observation at the time of operation. Perforations are best closed by Lembert sutures of fine silk placed six or eight to the inch, and, in the case of the bowel, transversely to its lumen. An ordinary cambric needle is best, and each suture should include the serous and muscular coats with the submucous fibrous layer.

In wounds of the stomach the sutures should be placed so as to bring the wound edges together in a line parallel to the long axis of the organ. Perforations on the mesenteric edge of the bowel may require enterectomy. Here suturing of any but the smallest wounds may result in kinking of the bowel and subsequent obstruction, or the vascular supply may be cut off and the vitality of the bowel directly opposite be impaired or destroyed. Should a number of perforations occur in a short length of

the bowel, one to three feet, necessitating more than one enterectomy, the entire damaged area should be removed and the ends united by end to end or lateral anastomosis. End to end anastomosis is to be preferred, but if more convenient lateral anastomosis may be made by bone plates (Senn), raw vegetable plates (Dawbarn), the Murphy button, or by suture (Abbe). If any doubt exists as to the vitality of any portion of the intestine after suturing an omental graft should be placed over the injured part. The graft is secured in position after scarification of the opposing serous surfaces by two fine sutures of gut or silk, fastening its corners to the mesentery. These sutures should be inserted parallel to the mesenteric vessels. It is to be remembered that in enterorrhaphy apposition of two serous surfaces as accomplished by the Lembert suture is sufficient. No time should be lost in applying complicated sutures. Suturing of all discovered perforations having been done the gas or air test should once more be applied to demonstrate the integrity of the canal. If there have been no fecal extravasations or other contaminations of the peritoneal cavity the operation wound may be closed at once. Should irrigation be necessary a weak antiseptic lotion may be employed, or, better still, warm sterilized water. After irrigation the abdomen should be made as dry as possible by sponging, drained and closed. Median incisions can be closed quickly and effectively by a single row of stitches, including all the marginal tissues. Incisions involving muscular structure must be sutured in layers. Ordinarily, incision in the median line gives the operator the best opportunity for treatment of intra-abdominal lesions, but cases occasionally occur in which the lesion may be most directly reached and treated by a lateral incision.

The success of laparotomy for penetrating gunshot wound of the abdomen, aside from the question of primary shock or exhaustion from hemorrhage, will depend upon the length of time which may elapse between the reception of the injury and the operation, the time consumed in the operation, the amount of exposure of the viscera by eventration, and the asepticity and thoroughness of the operative procedure. Early operations and those most quickly performed are the most successful. The onset of peritonitis before operation lessens the patient's chance of recovery, but should not debar him from its possible benefit. Treatment by the expectant plan has its ardent supporters. Undoubtedly cases of wound by balls of the smallest calibres, occurring when the hollow viscera were empty, have recovered under treatment by rest, immobilization of the abdomen, rectal feeding, and small doses of opium judiciously administered. In view, however, of the fact that perforation of the alimentary canal must, in a very large proportion of the cases, result in septic peritonitis from extravasation, and that such cases are almost always fatal, it seems to the writer that in every instance where perforation of the stomach or intestine is probable the explanatory operation ought to be made and such lesions as may be found treated surgically. The after-treatment of cases of gunshot injury of the viscera will be much the same as that in vogue for abdominal operations generally. Rest and quiet, with rectal alimentation, or stimulation if needed, and the control of pain will constitute the after-treatment. Symptoms of peritonitis must be dealt with promptly.



## CHAPTER VII.

### INJURIES OF THE PELVIC ORGANS.

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**Bladder.**—Wounds of the pelvis frequently implicate the bladder or rectum or both. Antero-posterior wounds of the bladder are very often complicated by wound of the rectum. The bladder may be wounded in connection with wound of the abdomen. One-half of the gunshot injuries of the bladder are complicated by bone injury (Von Bruns). The gravity of the injury is greatly increased by associated peritoneal wound. To the wound made by the ball may be added the damage done by splinters and fragments of bone detached from the pelvic bones by the ball and driven before it. Complicating fractures of the pelvic bones may occur at the wound of entrance or of the exit or at both, at the wound of entrance fracture constitutes a serious complication. The shattering of the surrounding bony walls with extravasation of urine or feces, the irregular openings often made in the fascial planes, make these injuries particularly liable to infection, followed by long continued suppurations, and the formation of fistulæ and sinuses. Balls or other foreign bodies affecting lodgement in the pelvis often make their way into the bladder by ulcerative absorption and become nuclei for the formation of calculi.

**SYMPTOMS.** Pain may be local, confined to the wound track, or if diffuse may be felt in the penis or testicles. Pain is generally intense and accompanied by severe shock. The patient will suffer from frequent desire to urinate, passing small quantities of blood-stained urine, or the effort to urinate may be ineffectual. If the wound leading to the bladder be small in size and tortuous there may be no leakage of urine; if the wound be large and at the lower portion of the organ urine may escape continuously; if it be patent and involve only the upper part of the bladder, escape of the urine will occur intermittently, that is only when the bladder is filled to the wound level. The rapid swelling of the injured tissues may prevent outward leakage. Bloody urine may be the result of contusion of the bladder-wall or injury to the ureter or kidneys. Complicating wound of the rectum may allow the escape of fecal matter into the bladder or of the urine into the rectum. Temporary paralysis of the bladder may be caused by the impact of a large missile over the pubic region. The existence of intra-peritoneal wound of the bladder may be suspected from the direction of the ball, suspicion will be strengthened if passage of a catheter into the bladder shows little or no urine in the bladder, and when the wound is large the point of the instrument passes into the peritoneal cavity. Filtered air may be injected into the bladder and positive evidence obtained of intra-peritoneal wound, if the air escape into the general peritoneal cavity. The formation of a circumscribed resonant supra-pubic tumor by the injection of air is not absolute proof of the non-existence of peritoneal wound for the opening may be valvular and permit leakage only when the viscus is partly filled.

**TREATMENT.** In cases where doubt exists as to the involvement of the peritoneal cavity the necessity of early interference if such wound exists makes exploration imperative. Exploratory incision should be made as in supra-pubic cystotomy, avoiding wounding the peritoneum until the pre-vesical space has been thoroughly examined. If the injury be there found it should be treated by suture or drainage, according to the conditions found. Failing to locate the wound in the pre-vesical space the bladder should be opened and its cavity examined by touch. If a wound be found communicating with the abdominal cavity the incision is at once extended upward and the peritoneal wound of the bladder sutured. Continuous or interrupted Lembert sutures of fine silk should be placed not more than an eighth of an inch apart and including the serous and muscular coats only. Foreign bodies discovered during the exploration of the bladder should be removed. If the condition of the peritoneal cavity, contamination by hemorrhage, urinary extravasation or beginning peritonitis necessitate irrigation drainage should be employed. The abdominal incision is closed in the usual manner. When free extravasation has taken place in the pre-vesical space or the perineum incisions must be made to relieve tension and remove extravasated fluid. Rest for the wounded organ must be secured, either by the use of the catheter secured in the urethra or by perineal drainage. The patient should be kept absolutely quiet. Diet, especially of fluids, should be sparing. Subsequent symptoms must be treated *pro re nata*. The utmost care should be used to prevent extravasation, and any indications of urinary infiltration promptly met by free incisions and antiseptic irrigation. Calculi forming after gunshot wound of the bladder must be treated by lithotomy, as, usually, the nucleus is a foreign body not amenable to lithotripsy.

**Rectum.**—Gunshot injuries of the rectum are rarely uncomplicated. Thus, Otis reports 103 cases of shot wound of the rectum. In forty-six cases there was described associated injury of the pelvic bones, but this is probably much below the actual number. Thirty-four cases were complicated by wound of the bladder. Wounds of the rectum may be accompanied by profuse hemorrhage, from section of an hemorrhoidal artery. Such cases have proved fatal in some instances. Extravasation of fecal matter is a frequent and serious complication, giving rise to profuse suppuration and to the formation of fecal fistula.

**TREATMENT.** Bleeding points must be secured by ligature if possible, otherwise by compression (gauze tampon). Any lesion open to treatment by suture should be closed. Antiseptic washing out of the wounded region should be done to prevent infection. Should fecal extravasation take place free incisions and irrigation will be necessary, or the practice suggested by Dupuytren and carried out in the war of the rebellion and the Franco-Prussian war with good results may be followed. This consists in backward section of the sphincters, so as to prevent retention of fecal matter in the bowel. The sequels of rectal injuries, recto-vesical fistula and fecal fistula, must be treated according to their individual requirements. They form an exceedingly trying class of cases.

**Genital Organs.**—Injuries of the male genital organs by gunshot are comparatively infrequent. Occasionally the genitals are wounded by a ball which has already traversed the pelvis or the upper thigh. The

wound may involve only superficial parts or may in its course injure the spermatic cord, one or both testes, or perforate the penis. Some cases of lodgment and even of encapsulation of the ball have been observed in the penis. Free hemorrhage, primary or secondary, may be expected from laceration of the corpora cavernosa. Extensive injury of the penis may occur without direct damage to the urethra, but generally that channel is wounded. The after effects of these injuries, according to their location, are stricture of the urethra, fistula, atrophy of testes and protracted or severe neuralgia. Gunshot wounds of the female genital organs have been rarely observed. Wound of the unimpregnated uterus rarely occurs without other serious pelvic lesions. Wounds of the pregnant uterus are followed promptly by miscarriage. Parvin cites three cases of gunshot and one of stab wound of the pregnant uterus in which all the mothers recovered after delivery of the wounded fetus.

**TREATMENT.** Superficial injuries of the genital organs should be treated antiseptically. Swelling from extravasation of blood should be relieved by incisions. In the deeper injuries conservative treatment must be employed. Hemorrhage must be checked by direct ligation of the vessel involved or suture. In all deep wounds of the penis, whether injury of the urethra be manifest or not, a catheter should be introduced and retained. If the urethra be extensively lacerated the introduction of the catheter may be impossible, and in such cases the advisability of perineal or supra-pubic opening of the bladder must be considered. Remedies to control erection will be needed. Neither penis nor testicles should be removed for any condition short of absolute disorganization. Deformities arising from cicatricial contraction of the penis may be amenable to surgical treatment later. Wounds of the female genitals must be treated upon general principles. According to Conner the menstrual flow may take place through a fistulous track following gunshot lesion of the uterus.

*Medication.* Monobromide of camphor and cannabis indica are of value in priapism arising from injury, though belladonna bromide of potassium, chloral and other sedatives may have to be resorted to in extreme instances where this condition is painful and continuous, due to injury, the cause remaining to operate to the patient's severe discomfort. Hypericum and pulsatilla are beneficial in painful states of the testicles, gelsemium, chamomilla, aconite and veratrum viride also being occasionally useful, especially when reactionary fever adds to the general suffering. Cantharis, cannabis sativa, apis and other remedies may be required for strangury and other symptoms arising from the urinary track.



## CHAPTER VIII.

### GUNSHOT INJURIES OF EXTREMITIES.

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**Application.**—Gunshot injuries of the extremities include all degrees of lesion from superficial injuries from spent bullets to destruction of a limb by large missile. They constitute in military practice nearly seventy per cent. of the cases coming under treatment (forty-two per cent. for the lower and twenty-seven per cent. for the upper extremities, Longmore). Wounds of the extremities may be multiple or single, from perforation successively by small, or carrying away by a large missile. Besides the large mortality due to these wounds, twelve to twenty-five per cent., according to Otis, there must be considered the grave after-effects, crippling the individual and interfering subsequently with his gaining a livelihood. Wounds of muscles and tendons may by contraction during healing render a limb useless. Deformity following fracture, ankylosis of joints and bad results after resection are among these crippling effects. The results of wounds of the large nerve trunks are particularly severe, including trophic changes, paralysis and hyperesthesia.

**Nerves.**—Nerve contusion may produce serious after-effects which are precisely similar to those resulting from laceration or partial section of the nerve. Loss of motor power, muscular wasting, changes in color of the skin, ulcerations, eczema, diminution of the tactile sense, painful cramps, permanent muscular contraction, absence of sweating, or profuse and offensive sweating, over the part supplied by the injured nerve, deformity of nails, neuralgia, causalgia and gangrene have all been noted as consequences of nerve injury. These conditions may be due to the primary injury or to subsequent involvement of the nerve by pressure of a cicatrix. Neuritis may ascend or descend from the point of injury.

**Blood Vessels.**—Wounds of the blood vessels are frequent, and cause a large proportion of deaths on the field. From want of parallelism, or other cause, the external wound may not permit the outflow of blood and large extravasations take place beneath the integument or fascia. Bruising of an artery or vein may result in occlusion at the point of injury or in such extent of injury of the vascular coats as to be followed by sloughing and secondary hemorrhage. Simultaneous wound of an artery and vein may result in arterio-venous aneurism.

**Fractures.**—Simple fracture of the long bones may occur as the effect of the blow of a large missile at low velocity, but the particular interest belonging to most gunshot fractures is due to their compound or complicated nature.

Gunshot fractures are usually of great severity from comminution and fissuring as a result of the direct violence which produces them; the rifle bullet, if travelling at high velocity, not only exerts force in the line of fire but produces large lateral effects in the shape of fissuring or splintering. Small shot and round balls are liable to

flatten upon compact osseous tissue, to bury themselves in spongy bones or to deflection. As a result of wound by a conical leaden rifle bullet there is generally found in the shafts of the long bones comminution at and about the point of perforation and fissuring which may extend through the epiphysis into the nearest articulation. Fissuring most commonly extends to the epiphysis. Perforation of the epiphysis is commonly attended by fissure into the joint. The fragments of bone detached by the comminution are generally found toward the wound of exit. With the small calibre mantled projectile it is found that within the zone of explosive effects there is comminution of both diaphysis and epiphysis with small fragments. Up to 600 metres the effect upon the diaphysis is splintering, while in some instances at 600 to 700 metres the wound of the epiphysis is clean and round without fissure. As the range is increased more clean perforations are noted in the epiphyses while the diaphyses are broken into larger fragments.

At 1,200 metres fissuring of the diaphysis is noted. At 1,600 metres fractures of the shafts occur with more periosteal cohesion of the fragments. At 2,000 metres fissuring of the diaphysis with still less displacement of the fragments. Lodgment of the new projectile occurs frequently when the velocity is less than 100 metres per second, that is, at greater ranges than 2,000 metres. It will be seen that the effects of the new bullet are similar to those of the leaden ball only in the middle ranges. Within the explosive zone it is even more destructive. With the modern projectile it is possible to have small, circular wounds of entrance and exit with great destruction of bony tissue between them. Complete fracture is recognizable by the ordinary signs, crepitus, deformity and preternatural mobility, corroborated by fragments of bone in the wound and, generally, large wound of exit. The percentages of mortality from gunshot fracture have been calculated upon the results obtained in pre-antiseptic times, therefore, are to-day of little use. Death in a large proportion of cases was due to septic infection, which in civil practice should be avoided in a majority of instances. The statistics which are obtainable from the reports of the small wars which have occurred within the last ten or fifteen years show favorable results from the employment of "field antiseptics."

**Joints.**—Wounds of the joints are met with in every degree, from contusion to complete disorganization. Any penetrating wound near an articulation may be followed by serious disturbance of the joint cavity, although the latter has not been entered by the ball. Non-penetrating wounds of the joint may give rise to inflammation by bruising the synovial membrane or by fissures from the wound canal through the articular extremity of the bone. Extensive lacerations of the soft parts may occur over the joint surface, and such wounds, becoming infected, may implicate the joint. Cicatricial contraction in the healing of wounds of this character may afterward impair the usefulness of the limb or render it useless. Penetrating wounds of joints are, in nearly all cases, accompanied by more or less injury to the articular surfaces, although it is possible for a ball to traverse the knee joint without touching the bones. With the round ball or ordinary revolver ball lodgment may occur. It is not likely to take place with the modern projectile except at very long range, and it may here be remarked that at short ranges, up to

500 to 600 metres, the effect of the mantled projectile upon joints will be especially severe. The diagnosis of joint injury by gunshot is clear when there is deformity of the articular extremities of the bones, escape of synovial fluid, rapid swelling from blood extravasation, and bone fragments are found in the wound of exit; but often these symptoms are absent, and penetration must be inferred from the direction of the ball judged from position of wounds of entrance and exit. It may happen in the case of the knee joint, as pointed out by Simon and Socin, that the wound is received when the joint is in semi-flexion. The joint being extended, parallelism of the wound is lost, the deep parts are shut off, making the joint injury subcutaneous and therefore likely to heal without suppuration. In these, as in most gunshot injuries, examination, if deemed necessary, must be made with the aseptic finger. Probing may convert a non-penetrating into a penetrating wound. Careful observation of the direction of the wound, with palpation to discover shattering of the bones, will have to be relied upon for diagnosis of penetration in many cases.

**Treatment of Injuries of Extremities.**—Contusions of the extremities, unless complicated by fracture or extensive extravasation, will be satisfactorily treated by compression by wool pads, bandage and rest. Complications of non-penetrating gunshot injuries must be treated on the general principles which govern the treatment of similar conditions due to other causes. The destruction or pulpification of the tissues occasionally produced by the impact of a large shot without penetration, if not immediately fatal, should be treated by amputation well above the site of injury. Flesh wounds, uncomplicated, are usually tubular channels, which, under antiseptic occlusion, heal by first intention. Flesh wounds complicated by lodgment, unless the ball be readily detected by palpation, should be occluded under antiseptic rules without search for the ball. Unnecessary probing and fingering are the bane of gunshot wounds. Infection of more wounds is produced by exploration with soiled fingers and probes than by the bullet. Wounds complicated by hemorrhage must be treated by ligation of the bleeding vessel in the wound. Free enlargement of the wound for that purpose should be made when necessary. The ligation should invariably be made above and below the lesion in the vessel when practicable. Otherwise, compression by aseptic tampon or ligature of the main trunk should be practiced. Chemical styptics should never be used. Ligation of the main vessels of any extremity will necessitate the use of artificial warmth to the limb, attention to position and every care to foster the return of circulation and to prevent gangrene. In all cases where the principal vessels of a limb are damaged the danger of gangrene must be recognized and, symptoms supervening, met by amputation.

Primary treatment of injuries to the nerves is seldom practicable, but whenever there is evidence of section of a large nerve trunk an attempt to resect and suture the injured nerve ends would be justifiable.

The treatment of gunshot fractures should be conservative and expectant. The checking of hemorrhage, antiseptic treatment of the wound, with no unnecessary interference with its interior, and immobilization are the points of treatment. The removal of bone splinters and fragments should apply strictly to those which are wholly detached.



Under asepsis many pieces of bone having a slender attachment by periosteum may heal in without necrosis. Large removal of fragments, like exsection of the diaphysis, should not be done as primary operations. A lodged ball need not be extensively searched for primarily, but when readily found should be removed. The amount of associated injury of the soft parts, blood vessels and nerve trunks must be the ground upon which to practice amputation for gunshot fracture. In military practice the impossibility, under the generally prevailing conditions, of giving conservatively treated cases the necessary after-care, and, possibly, the necessity for transportation of the patient, may determine the surgeon in favor of amputation. But in all cases where antiseptic measures can be carried out the surgeon will be governed as regards amputation for gunshot fracture by the modern rules governing treatment of compound fracture from any other cause. The best results in military practice are reported by Wagner from the Servio-Bulgarian war. The method employed consisted of irrigation to remove small detached fragments of bone and marrow, then filling the wound with a ten per cent. mixture of iodoform in glycerine and awaiting results under antiseptic dressing and immobilization. The mortality rate following this practice was one and one-half per cent.

To summarize the treatment of gunshot fractures, other than those wherein the damage to the soft parts is such as to result in the death or uselessness of the limb, accomplish the removal of detached fragments with as little manipulation as possible, preferably by irrigation; secure asepsis as far as practicable; mould splinters and fragments into place with the fingers; immobilize and await results. It may be added that where fracture is suspected, but not positively made out to exist, the case must be treated as if fracture were obvious. Manipulation to demonstrate abnormal mobility may convert an incomplete into a complete fracture. Wounds of the joints without severe lesion of the bones forming the articulation or of the soft parts should be treated by arrest of hemorrhage, thorough antisepsis of wounds of entrance and exit, and antiseptic occlusion with immobilization or extension. Where the osseous lesion is comminutive simple arthrotomy may be done to allow removal of detached fragments of bone and foreign bodies, to be followed by irrigation, drainage and fixation by splint with thick antiseptic dressing.

Total resection of joint surfaces is needed only for cases in which both articular surfaces are extensively destroyed. The results of extensive resections for gunshot injury are, as a rule, poor, the joint being flail like. In the knee and ankle ankylosis is preferable to flail-joint. In dirty wounds of joints with much laceration of the soft parts free opening of the joint is indicated, with copious irrigation and subsequent drainage.

Amputation in injuries of the joints is indicated only when the injury involves the soft parts to such an extent as to positively compromise the vitality of the limb. Under the application of antiseptic methods in the wounds of warfare great decrease in mortality of joint wounds may be expected. As an indication of what has already been done in the field it may be mentioned that in the Turco-Russian war Reyher treated twenty-eight cases of gunshot injury of the knee with a

mortality of 16.6 per cent. More than one-half of the cases (fifteen) recovered with useful joints. Von Bergmann reports fifteen cases with one death, and Farkas, from the Bulgarian war, reports nineteen cases of penetrating wound of the knee-joint, all recovered.

The most favorable report of pre-antiseptic times is that from the war of the rebellion, wherein the mortality from wounds of the knee-joint was 53.65 per cent. The practice of the future will rarely include amputation, resection only for exceptional shattering, and for the great proportion of wounds antiseptic cleansing, occlusion and immobilization.

## SECTION IX.

# SURGERY OF THE OSSEOUS SYSTEM.

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### CHAPTER I.

## THE CONSTITUENTS OF BONE.

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There are three different tissues which enter into the structure of bone: The periosteum, the bone substance proper and the marrow; to these three tissues should be added a fourth—cartilage, which does not exist, or exists only in the state of a terminal layer, in the bones of an adult, but which in the first period of life plays a prominent part in the formation of bone tissue. As these tissues have different physiological functions so also do they differ in pathological processes. It has generally been regarded that the absence of blood-vessels is necessarily a guard against inflammation; but as we find that articular cartilages become inflamed we must disabuse ourselves of that idea. In this case the cells proliferate and multiply until the inter-cellular substance is modified or absorbed. It is none the less true, however, that inflammatory processes are more rapid and destructive in tissues rich in vessels. These favoring conditions enable the inflammatory process to pass rapidly to suppuration, and this termination is all the more easily reached because the inflamed tissues are composed of young cells held together by another cellular substance of less resistance.

**Experimentation in Bone Pathology.**—It is not at all a difficult matter to develop osteitis in different degrees by experiments upon animals. If the periosteum, the medulla of the central canal, or the spaces of the spongy tissue be irritated the following conditions take place: The bone will at the end of two or three days be found to be tumefied at a point where the periosteum has been wounded; at first there occurs an effusion of blood; then the periosteum is infiltrated, swells and becomes thickened, swelling more the younger the animal experimented upon. Proliferation of cells is the cause of this thickening, which particularly affects the osteo-genic layer. In all cases of plastic periostitis there is this thickening of the periosteum in the osteo-genic layer. The next pathological stage covers the formation of new bone tissue in quite regular lamellæ or in pointed osteophytes. This is formed on the surface of the bone, and when it becomes excessive is known as an exostosis. The surface of the bone now becomes rugous; the canals of Havers which open upon its surface enlarge, giving this surface a honey-combed appearance which differs completely from the polish of the normal state. By the absorption of bone tissue the canals of Havers enlarge and proliferate



rapidly in young subjects. The first stage of osteitis, therefore, is the absorption of bone tissue by the medullary canal; but this absorption is temporary and is followed by reconstruction of bone tissue. The foregoing pathological conditions take place when the surface of the bone is subjected to irritation. If the central tissue be irritated the following phenomena are observed: There is an effusion of blood, followed by a thickening of the medullary tissue; the fat of the marrow is absorbed and the medullary tissue becomes fetal marrow; the medullary cells secrete a more resistant cellular substance which increases the subsistence of the tissue and gives a sclerosed appearance.

What has been described as taking place in the periphery of the canals of Havers will now take place in the periphery of the medullary canals, that is, absorption of bone substance and increase of space occupied by the medulla.

This covers a course of pure osteitis. The continuation of its history is either in prolongation of the process in the same direction, or in progressive reconstruction of bone tissue and resumption of normal compactness by the bone substance.

**Normal Compactness and Condensation.**—If the first stage be continued the hyperplastic medullar tissue soon resolves itself into pus. Leucocytes are present in abundance and accumulate en masse under the periosteum or in the canals. They are found more abundantly in the canals, which contain embryonal cells. Osseous matter which is thus bathed in pus cannot live long, becomes rapidly necrosed, and a suppurative osteitis which is acute or chronic, according to its rapid or slow progress, supervenes. Experimentation upon young animals may produce these different stages where they can be easily studied. It might here be mentioned that a traumatism which will inevitably produce necrosis in an adult will show only a rarefying osteitis in the child. Let it be supposed that a foreign body is introduced into the medullar canal of the shaft of the long bone. Suppuration appears at its site; the medullar substance is thus transformed into purulent granulations. The small, bony laminae are necrosed; beyond the point of suppuration the medulla is hardened and begins to ossify. The periosteum thickens, and there is an increase in the general thickening of the bone. Owing to this sub-periosteal enlargement the bone may attain double its size, associated with beginning necrosis, which is more or less extensive according to the compactness of the bone.

**Treatment.**—A free incision to the bone, trephining the same, the liberation of the pus, and the gouging out of the purulent granulations will limit the area of affected bone tissue and allow a reconstruction to take place.

## CHAPTER II.

# OSTEITIS, PERIOSTITIS, OSTEOMYELITIS, DIAPHYSITIS AND EPIPHYSITIS.

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**Analogy.**—All of these names simply designate a like process in different locality. The line of demarcation which would distinguish one process from another is not clearly marked; therefore, the terms are but arbitrary. The close relation existing between the different tissues constituting bone and the continuity of sub-periosteal layers establishes a physiological connection between these different elements and explains the closeness of pathological relations. Inflammation is readily communicated from one tissue to another. Formerly superficial inflammations were attributed to the periosteum, deep ones to the medulla. In the present day a closer distinction must be made. Inflammation may start in any one of the above described tissues, constituting bone, and may remain there for a short period or may quickly pass to other tissues. At other times it may simultaneously attack all the tissues of the bone; hence it cannot be spoken of precisely of osteitis, periostitis, or endo-ostitis, but simply be regarded as inflammation of the bone (osteitis). Take, for example, the femur; it is made up of three distinct pieces, the diaphysis and the two epiphyses. These latter are separated from the shaft by a connecting cartilage and being thus isolated anatomically form something of a barrier against the extension of inflammation. If the shaft is inflamed it is called diaphysitis; if the inflammation be of the epiphyses, it is epiphysitis; if all be inflamed it is technically a pan-osteitis, that is, an inflammation of the whole bone. This latter, however, is a rare condition. It must be remembered that in children the point of bone at which growth takes place is a favored seat of inflammation.

**General Symptoms.**—Setting aside the various localities wherein a bone may be inflamed, thus giving rise to the different names just mentioned, the symptoms here enumerated are peculiar to inflammation of bone in any of its tissues. Such inflammation is difficult to recognize because of the depth of the tissue affected. Not infrequently does the inflammation follow a slow course and give rise to little pain. Reference is here made to acute or sub-acute inflammations only. The chronic conditions will be considered under tubercular lesions. The name periostitis is only applicable to an inflammation of the periosteum, and this more particularly on its internal or osteo-genic layer.

**CHARACTER OF PAIN.** When a patient complains of a boring, or aching pain, deep seated, worse at night and aggravated by a dependent position of the part, we should be keenly alert to the recognition of the morbid condition, for in all probability it is a beginning osteitis. Tenderness exists on percussion and on deep pressure. Subperiosteal swelling shows itself by a general fullness of the part and later on by edema, or a boggy sensation imparted to the fingers. If a superficial bone be

involved there is discoloration. Osteitis having been diagnosed and a free incision made down to the supposed diseased area, there is yet a further knowledge necessary for the accurate recognition of the disease. An abscess forms; it is opened and the bone is not found denuded, but the periosteum only thickened at this point. This may be all there is of the lesion; but one must not be too ready to desist in exploration. It is easy to believe at first that the bone is intact, but on searching carefully a little denuded point is found which has been the origin of the abscess, found spread in front of the periosteum. There may have been a severe bruise over a considerable area, and the periosteum torn at a single point where the force has been direct. From this point the inflammation starts and thus osteitis, notwithstanding its slight extent, will keep up suppuration for days, weeks or months; therefore it is unwise to ignore the extreme probability that the bone participates in the inflammation.

It may be an axiom that whenever suppuration is developed on the surface of a bone and continues for a long period careful search must be made for a starting point of osteitis. Indeed, it is better to believe that a bone is affected; if the operator makes an incision with this belief he is not likely to desist until his search has been most thorough. A little indifference at this point may mean to the patient the loss of a bone or the entire limb, or life. Former writers have thought that the opening of the periosteum with a resulting discharge of pus was all that was necessary, and that the surgeon had done his duty to the fullest extent. Recent investigations, however, prove the falsity of this position. It is far better to make a long, even unsightly incision, thereby rendering a close inspection of the bone possible, than to be conservative and fail to cure the disease. Again, it is well to remember that because the periosteum being less resistant than bone pus, which has found its way to the surface of the bone just beneath the periosteum, may peel up this latter membrane for a long distance and insinuate itself into the lower extremity of the bone before it makes any outside demonstration of its presence. Therefore, if the incision be made at the point of pus exhibition the operator may yet be a long distance from the focus of disease. The only radical step is to follow up the loosened periosteum until the original focus is reached. The foregoing symptoms will apply to periostitis, osteitis, and osteomyelitis.

It might be well to speak here of the deep-seated pain of osteitis, and the frequency with which it is mistaken for growing pains. These deep-seated pains coincide with an absence of periosteal swelling and superficial pain, too frequently marking a transient stage of the disease; and as the patient complains only in a general way of dull pains both parent and physician may be inclined to regard them as simply the growing pains of children. Indeed, there is a great similarity between these growing pains and the pains of bone inflammation.

**SYMPTOMATIC OIL GLOBULES.** It sometimes happens in incising the periosteum as indicated by a swelling or possible fluctuation, particularly if that swelling be near an epiphysal region, that oil globules escape with the pus. These latter are due to a transudation of medullar oil through the canals of Havers. In acute or sub-acute osteitis the liquid which has been effused under the periosteum may find access to such region owing to the abundance of vascular canals, and the thinness of the compact layer which separates the periosteum from the bone near



the epiphysis. When the oil globules run together in a stream of almost transparent liquid they have very much the appearance of greasy broth. The author saw this condition in a boy eight years old, who had for some months previous what appeared to be a cold abscess near the knee joint. He had been lame and complained of pain; but as he was still about, his complaints were not regarded as sufficiently serious to demand much attention either from the parents or the attending physician. It was only when the condition became so severe that fever, emaciation and loss of appetite supervened that surgical treatment was resorted to. A free incision near the epiphysal end of the femur through the periosteum was followed by a copious flow of pus, very fetid in odor and generously intermixed with oil globules. The periosteum about the bone was completely separated and a large focus of osteitis exposed. This case exhibited well the possibility of ready communication between the canals of Havers and the surface of the bones by means of the epiphysal connection. So completely had been the destruction of bone that neither re-section nor sequestrotomy would avail and amputation was a necessity.

Some authors give to such a condition the name of albuminous periostitis. Here it might be mentioned that in the opening of any abscess near a bone the presence of oil globules indicates a greater or less degree of osteitis. They are due, as will readily be seen, to the transudation of the medullar oil and increased intra-osseous pressure.

**OSTITIS DURING THE PERIOD OF GROWTH.** To call attention still further to this condition in children a few symptoms might be mentioned. Growing pains usually occur in the evening after the child has played all day, or is fatigued in other ways. There is no appreciable swelling and no fever. The pains disappear with a good night's rest. Again, the pains may continue for several days and then cease. In the osteitis of growing children the pains invade a number of joints simultaneously and are accompanied by more or less febrile condition. The pains are more acute than are the growing pains. Growing pains are generally associated with fatigue, while the pains of osteitis are independent of such. There is scarcely a child that does not complain of these growing pains, located about the joints, especially the knee; and because of the existence of such pain the surgeon must be more on the alert to distinguish between them and those of destructive inflammatory character.

**Infectious Inflammation of Bone.**—Chassaignac gave this affection the name of typhus of the limbs. He also described a condition known as the epiphysal-osteitis of adolescents. Others have described it under the name of phlegmonous or diffuse periostitis. Volkmann has called it pseudo-rheumatic inflammation of the bones. Any or all of these names seem proper. Much discussion has taken place in former years as to whether these infective diseases were the result of a morbid condition of the system or whether their origin primarily produced a morbid condition. It is now quite well demonstrated that such a condition is the result of pyogenic organisms which have found other entrance than through an open wound or lesion and have been brought to the affected area in the blood stream. The symptoms are much the same as have already been described under osteitis, only they are more rapid in their onset. High fever, but not always chills; great pain of a gnawing or boring character, located ordinarily near the end of a long bone, and inability

to move the limb or muscles are the usual symptoms. The attack comes on more frequently at night after exposure to cold. The whole process is more rapid than that just described under acute osteitis. Swelling of the soft parts and redness of the skin are visible, quickly followed by fluctuation and pus-formation. The pus readily separates the periosteum from the shaft for a greater or a less distance, in fact, may do so from end to end, around the complete shaft. The temperature continues high and the pain excessive until the tension is relieved. Although this process may have been short yet probing the surface of the bone reveals dead tissue. As has just been stated, this condition comes on more frequently near the end of the bone, consequently the neighboring joint is involved. At times, though not frequently, the pyogenic organisms are carried from one end of the bone to the other without necessarily involving the shaft. Thus we have two distinct initial areas of infection.

**DIAGNOSIS.** Diagnosis can be made, largely, by the sudden onset and rapidity of the symptoms as distinguished from non-infective osteitis. It may, however, be mistaken for typhoid fever, acute rheumatism, or possibly if the redness of the skin supervene rapidly, for erysipelas. By observing the age of the patient, the location of the pain (close to a joint), its peculiar gnawing and boring character, and the absence of the rise and fall of temperature characteristic of typhoid fever the true nature of the disease will be indicated.

**PROGNOSIS.** The prognosis in this condition of bone affection should be more guarded than that of the non-infective. Death from septicemia may take place within two or three days from the onset of the disease. When superficial to the bone it is less dangerous than when central, as pus more rapidly reaches the surface and is more quickly evacuated.

**TREATMENT.** The treatment, however, has much to do with the prognosis. This is only effected by operation. The sooner the diseased area is cut down upon and a free exit to the imprisoned pus created the surer the recovery and the less likelihood of general septic infection. It is particularly important that no palliative measures should be undertaken. Herein lies great responsibility upon the attending physician. Hesitation, delay, simply mean bone destruction, constitutional infection and a probable death. It is better, even though no focus of bone disease be discovered beneath the periosteum, to trephine the bone in order to be absolutely sure of the perfect liberation of septic matter. This should be followed with irrigation by the sublimate solution for the destruction of the staphylococci. If it be ascertained that the medulla is involved it is good surgery to trephine at two different levels and scrape out the intervening infected tissue. An extensive suppuration of the periosteum does not necessarily mean the destruction of bone; for thorough destruction of bacteria may leave this tissue in such a condition that it will replace itself upon the bone.

### CHAPTER III.

## CARIES—NECROSIS.

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**Definition of Caries.**—Da Costa describes caries as suppurative osteitis with molecular osseous destruction, though some surgeons limit the term to strumous osteitis, others including under it all forms of osteitis with bone destruction. Osteitis is apt to become purulent when the bone is exposed to the air, when rest is not secured, when the health of the individual is abnormal, when a foreign body is lodged in the bone, and when struma or syphilis exists. In this condition the embryonic tissue becomes pus, which is discharged from the softened or granulating bone, and after drainage is secured organization, sclerosis and healing result. In all cases new bone may form and a cure obtain.

Caries necrotica is a condition in which small but visible portions of soft and dead bone come away in the pus. Caries sicca is molecular death of bone without suppuration. Bones which partake most of the cancellated structure are more frequently the seat of caries than those of a more firm and compact formation.

Formerly caries and necrosis were used as similar terms; now, however, they are regarded as distinct pathological conditions.

**Symptoms of Caries.**—As has been remarked in osteitis, when attacked by inflammation the ossific matter becomes acutely sensitive; and as in that condition so also in caries the commencement of the disease is characterized by acute suffering, so great as to prevent rest or sleep for weeks together. The part affected is considerably swollen, and if the bone be superficial there is swelling of the soft parts also; otherwise there may be little to externally mark the seat of disease. Soon there appears a fluctuating swelling due to pus, or a caseated tubercle. If this abscess be opened free evacuation follows and all the symptoms are relieved. If, however, it breaks a sinus is left from which is discharged a purulent matter that becomes thinner, reddish in color and irritating to the skin. This discharge contains minute particles of bone. The foul odor is quite characteristic of bone disease. The external orifice of the sinus is fringed with edematous granulations. In introducing a probe to the bottom of this sinus care must be exercised to let the probe find its own way as the sinus may be very tortuous, and, the tissues being soft, any guidance might easily divert the probe from the sinus and thus mislead the operator. When the diseased bone is touched by the probe it gives a muffled note rather than the clearer, sharper sound of necrosis. The bone layer is quite soft and is easily penetrated by the probe. In every instance of caries, where the resulting pus has found its escape to the surface, the chief means of diagnosis is the probe. There are some bones, however, which do not admit of the use of the probe. In such cases there will be the fetid odor and the corrosive, dark-colored discharge to make up the diagnosis. Tubercular caries will be considered under a separate head.



**Treatment.**—Rest and efficient drainage are the first necessary steps in the treatment of caries. If drainage cannot be obtained through the existing sinus the opening should be sufficiently enlarged to insert a tube or gauze drain, or even make additional openings. The cavity should be syringed with antiseptic fluids and dressed antiseptically. If the abscess has been discovered before it has broken it should be opened under strict antiseptic precautions. If the disease is chronic, as the vast majority of cases are, the question of immediate operation arises. There are conditions such as have just been named, wherein by securing perfect drainage and absolute cleanliness the lacerated bone may be thrown off and repair take place without operation; unfortunately, however, these conditions are rare, and it is wiser if the patient's general strength will stand the ordeal of the operation to incise freely down to the diseased bone, and remove every vestige of the carious structure. All granulations must be scraped away with the sharp spoon or gouge (see Fig. 44); the cavity must be swabbed out with pure carbolic acid, and packed with gauze. In severe cases excision may be required, and even amputation.

**MEDICATION.** If the inflammation is chronic the following medicines are resorted to, according to the corresponding symptoms in each individual case. Calcarea, phosphorus, silicia, sulphur and phosphoric acid. If osteitis is threatened from a blow or bruise arnica, calendula or ruta may be employed with benefit. If erysipelas appear belladonna, rhus or apis is indicated.

#### Definition of

**Necrosis.**—Necrosis, as used here, is the term applied to dead bone, although according to some writers it is applicable to soft structures. It is not difficult to understand this condition in bone if the surgeon has a clear idea of gangrene in the soft parts, for necrosis is to bone what gangrene is to other tissues. It is said

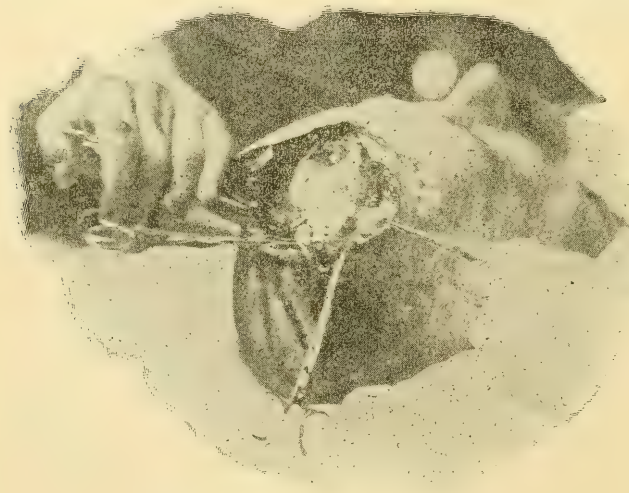


Fig. 30. Necrosis of Skull—Shears.

that denudation of bone causes necrosis. (See Fig. 30). Ollier contends that numerous and varied experiments prove that this is not so, claiming to have removed the whole of the periosteum of the diaphysis in young subjects, and to have completely emptied the medullary canal without producing necrosis. He says he has, in certain experiments, removed simultaneously the periosteum and the medulla without causing death of the bone. But he adds that in order that life shall be preserved in these cases it is necessary to obtain immediate union of the wound; that is to say, immediate adhesion of the peripheral tissue to the denuded bone

and the prevention of the formation of pus in the medulla. Hence, it is not the denudation of bone that causes necrosis; but the infection and inflammation which follow the denudation. This statement is now universally admitted to be true. (From recent operations upon bones under strict antiseptic precautions it is shown that the surgeon can denude, suture or resect portions of them without necrosis following, and this knowledge has almost revolutionized bone surgery).

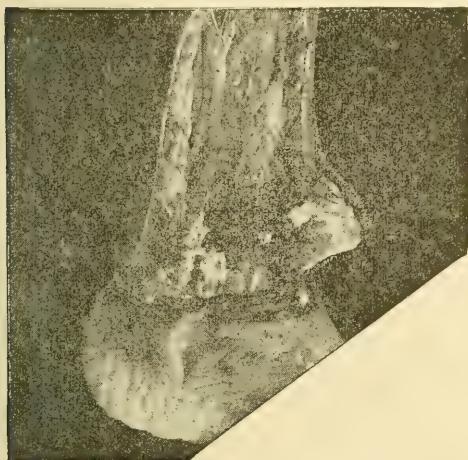


Fig. 31. Necrosis of Tibia and Calcaneum—Winnard.

body; the healthy bone adjacent to it is inflamed, softens and granulates. Thus there is formed a line of demarcation made up of granulations, as in gangrene of the soft parts. This separates the dead part from the living. The dead bone is white or yellowish-white, and is surrounded by a red zone of granular tissue. This white, dead bone is called a sequestrum. It now becomes nature's work to cast off this offending member. If it be superficial and readily cast off the process is denominated exfoliation.

Nature's method of casting off the sequestrum is interesting. The line of demarcation has formed; to hasten this mark suppuration steps in; osteitis, already

existing, makes the process of suppuration more rapid; at the same time that this is taking place the periosteum, which has become separated from the necrosed bone and which is yet in a healthy state, begins to reproduce from its osteogenic layer a new surface of bone (see Fig. 32); as the old bone loosens and becomes displaced this new bone forms the periosteum, covering around and



Fig. 33. Necrosis of the calcaneum; ossification of the periosteal sheath around the necrosed bone. (After Gerdy.)

Before the days of antiseptic surgery to expose a bone beneath its periosteum invariably meant necrosis. It does not follow because necrosis is less frequent under asepsis that in traumatism which produce denudation of bone the condition is not a serious one. As has been stated, necrosis results from acute inflammation of the bone. A thin shell of bone only may necrose from periosteal separation, as an entire shaft may perish from diffuse infective periostitis. (See Fig. 32.)

The fragment of dead bone becomes a foreign



Fig. 32. Case of necrosis from the Musce pupyren. Almost the whole of the diaphysis of the humerus has perished. The new bone is completely solidified. Cloaca are seen, openings which expose to view a large, movable, invaginated sequestrum free in the cavity of the new bone. (Musée Dupuytren, No. 346.)



boxing in the loosened sequestrum. This may be held in so tightly that it cannot escape, but the pus must find its way to the surface and so permeates through the new covering of bone. The orifices which the pus has thus made in the involucrum are called cloacæ. Sometimes the involucrum may be honeycombed by the cloacæ. There is then presented a peculiar complex condition not infrequently seen, namely, a case of new bone, known as the involucrum, a cavity containing pus, and the dead fragment of bone. (See Fig. 34.) The suppuration which must go on during this process is a great bar to the successful completion of the

undertaking. In such cases the surgeon cuts through the healthy bone, removes the sequestrum, washes out the pus and scrapes away the granulations; nature will do the rest. When a portion of bone surrounding the medullary canal dies the condition is called central necrosis, and these central sequestra may remain in position for years.

**Symptoms of Necrosis.**—The symptoms of necrosis are, as with caries, the same as in osteitis. There are the abscess, the liberation of pus and the sinus. When the probe is introduced into the sinus it strikes the bone with a clear, ringing sound, quite different from the muffled note of caries. In superficial necrosis the discharge is slight; in extensive necrosis it is profuse. In youth dead bone loosens quickly, in old age slowly, as exfoliations become loose sooner than the deep-seated or central necrosis. The separation of the dead bone from the living is a slow process, occupying two, three or even four months. Generally this process should be waited for rather than removal of the bone by operation. Just as it is good surgery to wait for the lines of demarcation before amputation so it is good surgery to wait for a complete or partially complete separation of the sequestrum before its removal is undertaken. The removal of a sequestrum is called sequestrotomy.

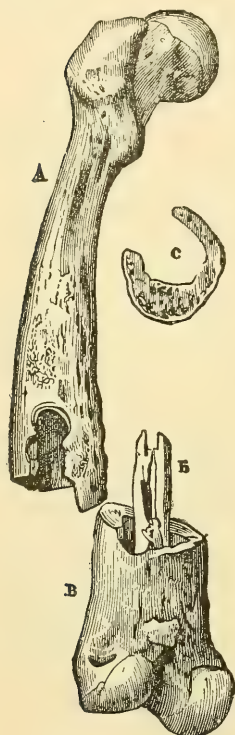


Fig. 34. Invaginated necrosis of the lower part of the femur. The bone is represented cut in three pieces. *A*, the upper fragment; at its lower part is seen a large hole made with the trephine. *B*, is the lower fragment; the sequestrum is seen to be invaginated at the end toward the condyles. *C*, is a section of the bone which shows the areolar structure of the ossification.

**Mode of Repair.**—One of the most interesting phenomena to be studied in relation to necrosis is the mode of repair of necrosed bones. For a number of centuries there have been noticed after necrosis examples of the regeneration of bone, and the explanation which was given of these cases was always based upon the physiological idea of the time.

Later the regeneration of bone was thought to be dependent upon the periosteum. The periosteum is unquestionably the most important tissue in the regeneration of bone; it is the only tissue which can bring about regeneration of a considerable portion of bone, or of an entire bone. Its ossifying properties are dependent upon the conversion of its osteogenic layer, the layer which exists on its deep surface. While this layer is prominent in children it disappears to a great extent in adults and old persons. It is known that artificial irritation to the periosteum re-



stores to this membrane in old animals the properties of youth. For this reason bony new formations are not limited to childhood and youth. (Ollier.) They may be produced at a later period when the periosteum has undergone a certain degree of irritation, which renews in its cells the properties they had lost. Therefore we know that regeneration of bone in necrosis is dependent upon the presence of the osteo-genic layer. If this layer has been destroyed by the violence of the inflammation, as occurs in diffuse periostitis, in which case the periosteal sheath becomes a purulent sac, regeneration may utterly fail in spite of youth and all favoring circumstances. Therefore it cannot be argued that because the subject is young and there is an apparently preserved periosteum regeneration of bone necessarily follows where necrosis has existed.

**Treatment.**—**SEQUESTROTOMY.** Whether the complete separation of bone has taken place or not the first duty of the surgeon is to establish free drainage with aseptic surroundings. Thus nature is aided in her efforts to effect her process as rapidly and with as little harm to the system as possible. When the sequestrum becomes loose, and this must be determined by means of the probe, forceps or finger, the course to be pursued is very clear. The new layer of bone (the involucrum), if such exists, must be cut through with a chisel, gouge or trephine. Usually it is necessary only to seize the fragment with the bone forceps and take it away by force. The cavity must now be well cleaned and packed with gauze. This operation is known as sequestrotomy. If the gap is very large it can be filled with bone chips. These are decalcified pieces of bone which have been specially prepared for the purpose. The periosteum is then stitched over the opening, the soft parts treated similarly, and the whole dressed with iodoform. This operation is generally quite satisfactory. The cavity rapidly fills with granulations which soon form into fibrous masses and finally ossify, especially if the periosteum can take part in the process. This is particularly true in young subjects.

**GERSTER'S METHOD.** Gerster describes a method of performing necrotomy which is much better than the ordinary mode of procedure. It is as follows: The parts being well cleansed with soap and hot water they are shaved and disinfected by mercuric irrigation. Esmarch's bandage is applied and an incision is carried down to the bone over the inner fistulæ. The length of the external incision should be proportionate to the extent of bone thickening. The thickened bone should always be attacked where it is most superficial, the site of the incision being determined rather by the question of accessibility than by the location of the sinuses. Where the bone is superficial, as the tibia, for instance, an incision may be at once carried down to it. Where there is a thick massing of overlying tissues the incision should be gradual and preparative, and all cut vessels should be at once ligated. The periosteum is pried up



Fig. 35. Bone Elevator.

on both sides of the cut with an elevator and where it is found adherent by cicatricial tissue is cut away until the entire affected area is well exposed. The integument and periosteum are held back with a pair of Volkmann's retractors, and the roof of the cavity containing the sequestrum is chiseled away.

This can be done very rapidly in a workmanlike manner with the mallet and chisel until the sequestrum is completely exposed. This being done the sequestrum



Fig. 36. Retractor.

is lifted out of its bed with a pair of forceps. The irregular edges of the cavity are next smoothed off; the overhanging parts are removed so

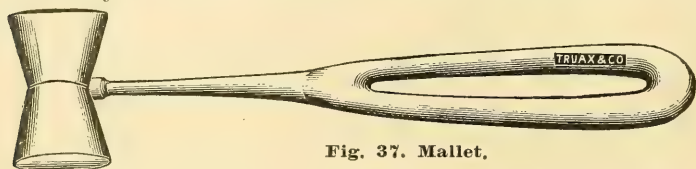


Fig. 37. Mallet.

as to permit a thorough and careful examination of the recess. No dead bone must be left behind. A sharp spoon should be used with vigorous strokes to clear away all granulations or softened osseous tissue until the entire wounded surface presents a clean and healthy appearance. Debris and shreds of granulations are flushed out with a strong and rigid stroke; and to make sure that no detached particles of tissue are left behind the cavity should be mopped out with a clean wiper. Where the operator is not certain of having rendered the cavity perfectly aseptic it is best not to apply sutures, but to fill it with a loose packing of iodoform and gauze and to place the limb in a loose compressive dressing. The dressing should be ample and should contain an external layer of absorbent material, as, for instance, absorbent cotton. The turns of the roller bandage should be tight and close to insure a sufficient amount of local compression as a safeguard against secondary hemorrhage. Ample padding will prevent strangulation.

**MEDICATION.** The process of the separation of the sequestrum may be hastened by the administration of certain remedies. Sulphur, mercurius, bryonia, calcarea phosphorica and silicia are especially deserving of mention.

## CHAPTER IV.

### OTHER DISEASES AND TUMORS OF BONE.

**Osteo-Malacia.**—There is a condition in which an altered nutrition of bone takes place which ends in absorption of the calcareous cells of the bone substance and in the melting away of the bony trabecule (Ranvier), and, clinically, by loss of the normal hardness and resistance of the bones and deformities of the skeleton, which are more considerable as softening is more marked. The first authentic account of this condition was made by an Arabian, Gschusius. This physician had seen a man who could move only his tongue, “and who had himself carried upon a matting of palm, because he had no bones except in his head, neck and hands; and because the other parts of his skeleton, from his clavicle to his feet, bent like cloth.” The condition of osteo-malacia is more common before than after middle life, and is commoner in women than in men. There is a close relation between this condition and pregnancy. In mild cases the bones may preserve their normal dimensions and color, but in typical cases their size is very great, and they undergo alteration in color. The consistency of the bones differs with the degree of the disease. They may be flexible as a reed or only like bone which has been decalcified in acid. As a rule the bones are easily bent, resembling india-rubber tubes. The weight of the bones in osteo-malacia diminishes with their consistence.

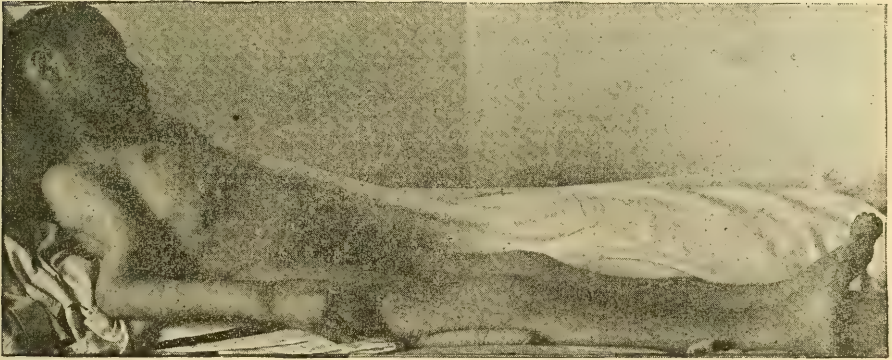


Fig. 38. Osteo-Malacia—Author's Case.

**SYMPTOMS.** It is difficult to make out the existence of this disease until the softening of the bone has reached that stage in which bending becomes perceptible. There may be pains in the bones. The disease progresses slowly and may last a number of years, usually resulting in death from exhaustion. There is no surgical relief for this condition and the only recourse is in diet, sanitation and internal medication. The remedies that will be indicated are *natrum muriaticum*, *natrum phosphoricum*, *ferrum phosphoricum*, *baryta carbonica*, *silicia* and *sulphur*.



**Fragilitas Ossium.**—By this is meant an abnormal fragility due to rarefaction of the bones, which are easily fractured. The condition is generally a sequel to disease, although there are conditions wherein the tendency to fracture upon slight provocation seems to exist without any previous pathological process being known. Fractures from this cause are treated as other fractures. There is no special treatment save that of protecting the individual from traumatism as much as is possible.

A peculiar fact which might be mentioned in connection with this disease is that individuals who have sustained a considerable number of fractures become smaller in consequence of the over-riding of fragments. It is reported that at the Middlesex Hospital, London, there was a girl fourteen years old who had had thirty-one fractures in eleven years. One tibia had been broken nine times. One fortunate peculiarity of this condition is the ease and rapidity with which union takes place.

**Bone Tumors.**—To a limited extent the same neoplasms that are seen in soft parts are also met with in osseous tissues.

**EXOSTOSES.** By exostosis is meant an abnormal and circumscribed production of bone tissue on the surface, or in the interior of a bone. (Duplay.)

It is common to speak of the mass protruding into the interior of the bone as an endostosis. It is best to distinguish between an exostosis and a hyperostosis. By the latter is meant a general thickening or enlargement of the entire surface of the bone. Some of the older authors divided exostoses into eburnated exostoses and spongy exostoses. In shape exostoses may present numerous varieties. They may be shaped like a sponge, pedunculated or sessile; or they may be broad-based, more like hyperostoses. They may vary in size from that of a small prominence to that of an adult's fist. Cases of multiple exostoses are reported by Leidy, Campbell and Clarke. In Clarke's cases the tumors, large and small, were innumerable; they involved all the bones of the body except those of the skull. In Leidy's cases they numbered one hundred and twenty-six. The largest outgrowths were found upon the femur, tibia, fibula, pelvis, scapula and ribs. All of these growths were reported to be of stony hardness; they were pedunculated, sessile and irregular; the pain was only mechanical.

**CAUSES.** These growths may be caused by contusions, localized inflammation, ulceration and syphilis.

**TREATMENT.** Medical treatment will avail but little in any of these cases save those of syphilitic origin. Surgical treatment, therefore, is the only means available for radical relief. But even this is not easily exercised, because of the danger which attends removal of these growths when deep-seated. It is wise, therefore, to let them alone except in cases where by mechanical pressure they interfere with locomotion or proper function. They are reached by a free incision to the growth, which is removed by the gouge, chisel or Hey's saw.

**Fibrous Tumors.**—Fibrous tumors of bones are rare and easily confounded with sarcomata. They are made up of fasciculated, fibrous tissue.

Fibromata may undergo transfoliations, or they may become calcified. They may also undergo fatty degeneration or may become cystic. In rare instances they become very vascular.

**TREATMENT.** The treatment of fibrous tumors of bone lies in total extirpation.

**Chondromata.**—Chondromata is characteristically a disease of bone tissue. By the name is meant tumors of more or less abnormal cartilaginous tissue. (Lucke.) Early writers who made a study of this condition are Vogel, Labert, Paget and Virchow. Bone chondromata are made up of the structures which enter into all the varieties of cartilage in man.

**SHAPE AND SIZE.** In shape chondromata are usually spherical or oval; sometimes the tumor is soft and fluctuating over a great part of its surface, and its contents are of a viscid, ropy and colloidal appearance. Cysts may develop in chondromata, either under the influence of softening or as a consequence of rupture of the blood-vessels. They may arise from embryonic tissue formed by a process analogous to that of osteitis. There is no marked effect upon the surrounding tissues unless by the enormous size there is a giving away of the skin under extreme tension. The bones themselves are thin and eroded. These tumors are found more frequently in young persons. They may often be congenital, heredity having its effect. The only characteristic symptom, aside from their size, is the parchment-like crackling which is produced by manipulation.

**TREATMENT.** The treatment is invariably surgical where the tumor is accessible.

**Pulsating Tumors.**—Pulsating tumors are rare. Nelaton collected six cases and named them aneurism of bone. Volkmann collected four cases. Landi records nine. In all these cases pulsation was distinct except in one, in which there was a perceptible blowing murmur.

As will be readily imagined the chief difficulty in diagnosis lies in distinguishing these tumors from aneurisms. It should be ascertained whether the pulsation seems to be defined or compressed by the periosteum. This tissue will offer some resistance to the throb. It is difficult, however, to distinguish clearly between an aneurism of anastomosis and an aneurism of bone. These tumors are prone to grow quite rapidly.

**TREATMENT.** If the tumor be in a surgically accessible area it is best to remove it by a galvano-cautery the better to control hemorrhage. Or, if this can be controlled by packing with gut-wool it is proper to empty the latter. Of the nine cases which Landi treated two were cured by ligature of the main artery of the part, two ceased to pulsate, primary amputation was successful in three and fatal in two.

**Cysts of Bone.**—Cystic cavities not infrequently occur in bones. They may undergo degeneration and resolve themselves into simple bony abscesses. The true bone cyst is of parasitic origin and is then known as a hydatid cyst. There is a variety of cysts which occurs in the maxillary bones known as dental cysts, cysts of the periosteum, cysts of the roots, and dentiferous cysts. These properly belong to dental surgery.

True bone cysts are single-celled and multiple-celled. They sometimes attain large dimensions. One case reported by Nelaton extended from the trochanter of the femur to the condyles. The internal wall of these cysts is covered with a membrane having the smooth appearance of mucous surfaces, sometimes being lined with fibroid vegetations. The contents of true cysts are either pure serum, sero-sanguinolent serum, or a thick, gummy substance. Nearly all cysts contain *ecchinococci*. The



progress of this disease is due to the presence of the parasite, which makes a hollow cavity for itself in the bone, this increasing as the vesicle is developed. It gradually distends until only a shell of bone covers it. These cysts are met with in any bone. A number of the bones may be affected at the same time. Volkmann considers bone cysts as metamorphosis of solid tumors. Traumatism seems to play a certain part in their development.

**SYMPTOMS.** Little or no pain and no inflammation attend the development of these tumors. The first symptom is a swelling of the bone. It is at first hard, and afterward develops the peculiar parchment-like crackling which has already been described under the head of abscesses.

**TREATMENT.** The treatment of bone cysts consists, first, in puncture, combined with irritating injections; second, incision, which is simply emptying the cyst of its contents; third, packing the cavity, allowing nature to complete the cure. The contraction of the sac does not begin immediately, and may be delayed for some weeks. Where the cyst is of great size, with little indications of a final contraction, amputation becomes necessary.

**Sarcomata.**—Sarcomata of bone is a disease of early life, occurring often in infancy or childhood and rarely occurring after forty years of age. Histologically, osteo-sarcomata may be divided into three varieties, round-celled, spindle-celled and giant-celled. Locally, they are divided into two varieties, central and periosteal. The smaller the cells the greater the malignancy, especially if they be small, round spindle-cells. When external the progress is more rapid than when central.

The maxillæ and the long bones are the most frequent site. Their

development is more rapid than that of benign tumors. These tumors are abundantly supplied with blood-vessels, so much so that they may resemble the pulsatile tumors. Some authors believe that aneurisms of bone are nothing more than sarcomata, and that osseous carcinomata are rarely seen except as they occur secondarily.

A case which recently came under the author's observation was that of a physician with a large sarcoma of the lower end of the femur. Its origin was apparently traumatic. The growth had been quite rapid, extending over a period of a few months. The diameter at this point was about twenty-four inches. It had broken down and was discharging externally. There had been frequent and alarming hemorrhages which

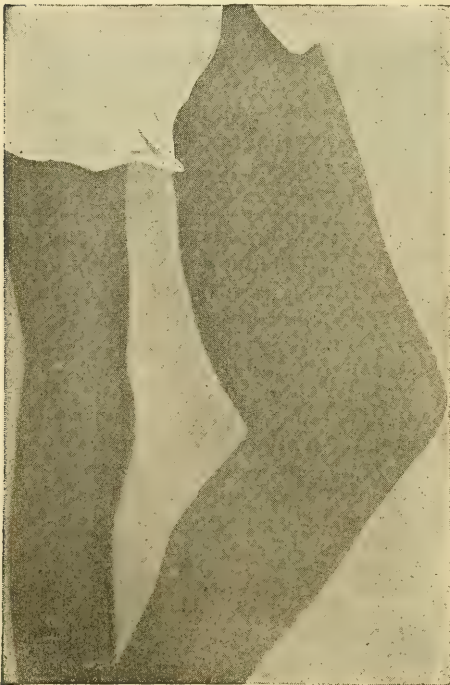


Fig. 39. Sarcoma of Femur.



had been controlled with difficulty. So much of the bone was involved that a resection did not promise good results, and as he was averse to amputation nothing was done for him and he died from a hemorrhage which could not be controlled. Herrgott reports a case of sarcoma of the leg where that member became so large that it could not be put into a potato bag.

**SYMPTOMS.** Pain is seldom absent. Swelling is recognized early, particularly if the growth be of external variety. If of the internal variety swelling appears later. The growth is either globular or pear-shaped in appearance. There is increased temperature over the part and but little impairment of the neighboring joint. It may be confounded with rheumatism because of the character of the pain, the swelling and heat, particularly as it is usually near a joint. If consideration be given to the age of a patient and there is no previously existing rheumatic diathesis the nature of the disease is more easily determined. There is rapidity of enlargement and a tendency to pulsation.

**TREATMENT.** The treatment must be radical to be effective; but the same rule holds here as with malignant growths elsewhere. No promise can be made against the return of the growth in another locality. If the tumor be in the femur and disarticulation of the hip is required to effectually remove the growth there should be due consideration of the patient standing the shock. In any case the probabilities of reappearance are very strong, even in the least malignant variety; the proportion of recurrence of the spindle-cells is about one in five.

**Carcinomata.**—Except as it occurs secondarily carcinomata is believed to be practically unknown. As in sarcoma of the bone recourse must be had to the knife, where the neoplasm is surgically accessible. But there can be no promise of cure.

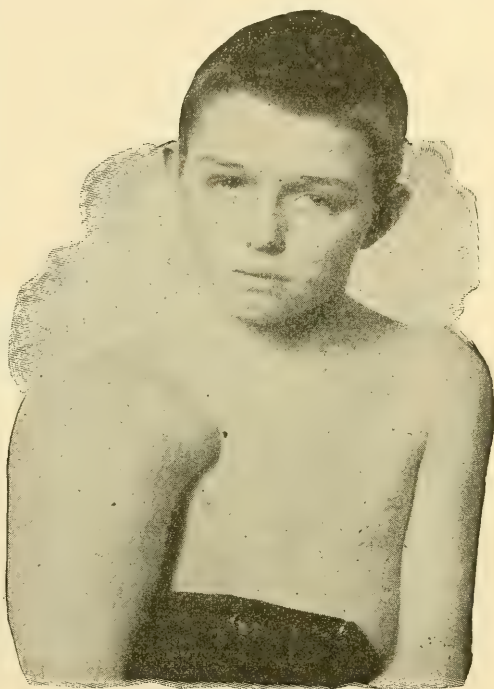


Fig. 40. Sarcoma of Humerus—Shears.

## CHAPTER V. OSTEOTOMY.

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**Definition.**—Osteotomy is a cutting operation upon bones for the relief of deformities. It may be done by an open incision, or sometimes the deformity is overcome by osteoclasis. Osteotomy is an operation attended with but little danger and but two points of menace need be borne in mind. First, sepsis; second, wounding of important nerves or blood-vessels.

Of the former there need be little fear by the surgeon of the present day if he but observe his primary lesson of asepsis. Of the latter he need also have but little fear if possessed of a thorough knowledge of the location of blood-vessels and nerves, and if he make reasonable allowance for mal-position of the same.

**Instruments.**—The instruments employed in osteotomy consist of especially designed saws, chisels, osteotomes, mallets, scalpels, blunt hooks and sand pillows. Of the saws employed among the best are Langen-

beck's and Adams'. The blades are short and strong, a quarter of an inch in width and an inch and a half in length, connected with the handle by a strong shank three inches long. There is some objection to the saw being used, from the possibility of lacerating the contiguous parts and the retention of bone dust in the wound, which, failing to be absorbed may be followed by suppuration.

Shrady has devised a saw which he describes as an instrument consisting of a trocar and a staff with a handle and blunt extremity. A portion of this shaft is flattened at a short distance from the extremity, one edge being made into a knife-blade and the other being provided with soft teeth. This shaft is intended to replace the trocar in the canula, after the latter is introduced. When in position either the saw or the knife-edge, according to the way the latter is turned, corresponds with the opening of the canula. The saw or knife can then be worked within the canula by the piston-like movement, the canula being steadied by grasping the flange at its base. If it be necessary to work the instrument as an ordinary blunt-pointed, sheathed saw or knife the shaft can be fixed in the canula and made into one piece by means of a thumb-screw in the handle. The portion of the canula at the back of the opening is made specially strong and is of the same thickness of the blade, so that in sawing there is no

stoppage of the passage of the instrument through any thickness of bone. All that is necessary in using this instrument is to thrust the trocar and canula into the limb, the fenestrum of the canula being alongside of the bone upon which the operation is to be performed. The trocar is then

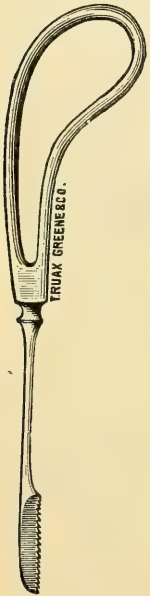


Fig. 41.  
Adams' Saw.



Fig. 42.  
Bone  
Chisel.

withdrawn and the shaft introduced into its place and worked as already described.

The chisel is not unlike that of the carpenter's chisel, differing simply in temper. It should be one-eighth of an inch thick at the base of the bevel. This is an important consideration, as greater thickness is liable to splinter the bone. Various breadths may be used, according to the bone upon which the operation is to be performed. The width should always be less than the bone under treatment. It might be well to test the temper of the chisel upon one of the hard bones of an ox before beginning the operation. A straight section directly through the bone should not be attempted as the chisel is apt to go awry under such use. A wedge-shaped piece of bone should first be removed, and then the chisel may cut directly into the bone.

The osteotome should be beveled on both edges, resembling a slender wedge. It should be metallic in its entirety, having no detachable handle. One side of the blade should be marked in inches to determine the depth of the incision. The edge should be sharp and of a temper sufficient to withstand the strain required.

The mallet is made of hard wood, metal or rawhide. The scalpel and blunt hooks are such as are used in general operations.

A sand pillow will be generally needed to support the operable part. It should be sufficiently large to allow the limb to rest upon it comfortably, eighteen inches by twelve inches being a size adequate to most operations. The pillow should not be filled full of sand, but sufficiently so to permit of its contents being moved from one part of the bag to another without leaving any portion empty. The limb is rather imbedded in it than laid upon it. By use of this pillow the soft parts are materially protected from injury.

**The Operation.**—In making the incision through the soft parts which lead down to the bone the location should be selected, first, in accordance with the portion of bone to be severed and, secondly, according to the location of blood-vessels and nerves. It should be made in the long axis of the fibres of the muscle and down to but not through the periosteum. Bruising of the soft parts will be avoided if the blade of the scalpel be left in position until the chisel is introduced into the periosteum, as by withdrawal of the blade before this introduction the muscles may so contract that the opening made by the knife may be lost sight of. It is just as well to make the opening sufficiently large to admit the finger or to permit the inspection of the bone. A comparatively large incision is less objectionable than a too contracted opening. The limb should be rendered bloodless by the application of the Esmarch bandage.

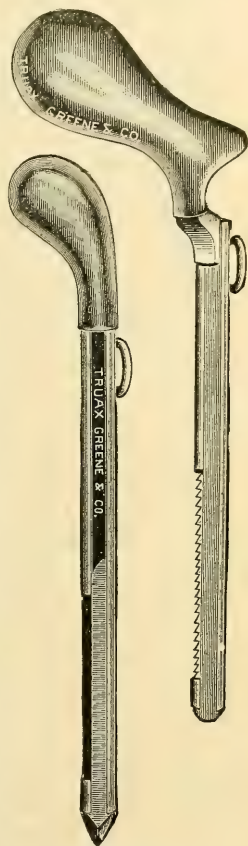


Fig. 43.  
Shady's Bone Saw.



**Sub-Cutaneous Division of the Neck of the Femur.**—This operation is rendered necessary only in rare instances, as in ankylosis of the hip-joint, wherein it is desired to form a false joint at the neck of the femur. A long slender scalpel is introduced just above the top of the great trochanter straight down to the neck of the femur. The muscles are divided and the capsule opened by cutting upward. The small Langenbeck or Adams saw is passed along the side of the knife to the interior surface of the neck which is then sawed transversely from before, backwards. It is not necessary to saw entirely through the bone, but just sufficiently to allow it to be broken easily. The limb is then placed in position, the wound thoroughly cleansed with antiseptic solutions, especial care being taken to wash out the bone dust. The hemorrhage should be checked and a small drainage tube introduced to secure proper cleansing. The limb is then placed in an immovable apparatus, and should there be too much tendinous contraction these offending tendons can be divided sub-cutaneously. Bryant reports that this operation has been successful in thirty-one out of forty-four cases.

Fig. 44.  
Bone  
Gouge.

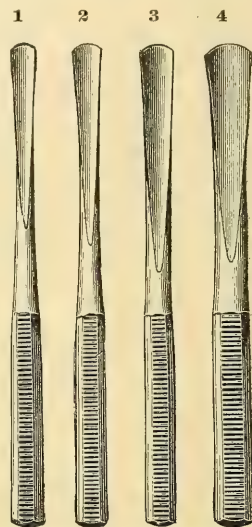


Fig. 45. Aseptic Chisels.

There is a modification of this operation spoken of by Volkmann which consists in making an incision along the posterior surface of the great trochanter and removing the periosteum from two-thirds of its circumference, when, with chisels and gouges, a triangular piece is taken from just below the trochanter, the bone broken, straightened, and held in position until union takes place. He reports twelve operations thus performed, all recoveries.

**Osteotomy for Bony Ankylosis of the Knee Joint.**—Having located the rectus tendon, a longitudinal incision sufficiently large to admit the finger is made about one inch above the outer condyle. The osteotome is introduced and the cutting edge is turned so that it is transverse to the long axis of the bone. The limb is placed upon the sand bag and about two-thirds of the bone is divided with a chisel and hammer; the remainder is broken or bent. This operation may also be performed from the inner aspect of the knee joint. The incision is then made along the internal border and half an inch in front of the adductor magnus, beginning one inch above its insertion, the subsequent steps of the operation being the same as in the other operation. It is possible by this operation not only to straighten a leg that is contracted upon the thigh, but it is also possible to gain a false joint, especially in younger subjects, and thus restore the limb to a large degree of usefulness.

**The Correction of Genu Valgum by Super-Condylod Osteotomy.**—Genu valgum is the deformity known as “knock-knee.” For its correction an incision is made through the soft parts of the inner side of the limb, beginning half an inch above the insertion of the tendon

of the adductor magnus into the spine at the upper portion of the internal condyle, half an inch in front of this and carrying it up sufficiently to admit the osteotome. Its lowest limit corresponds to a line drawn trans-

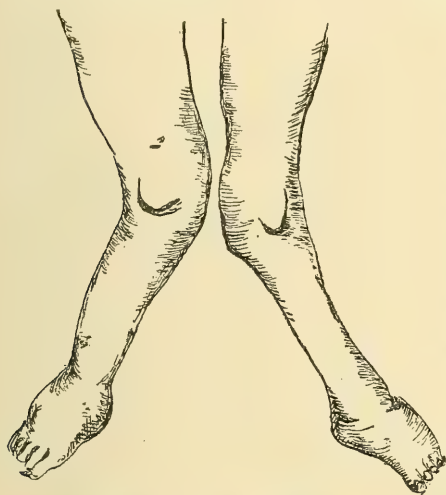


Fig. 46. Genu Valgum.

versely across the limb in front, beginning an inch above the external condyle which will, if the internal condyle be much elongated, prevent the osteotome being driven into the external condyle instead of above it. Care should be taken to have the popliteal vessels, the anastomotica magna and the superior internal articular arteries, together with the synovial pouch of the knee-joint, on the interior surface of the femur. The osteotome should be applied to the bone transversely, at the point indicated at the line extended across the posterior surface of the femur to a point half an inch above the external condyle. If the bone is not too dense it can be cut through two-thirds of its diameter and then broken; if dense it may be necessary to cut almost entirely through. The posterior and inner surface of the bone are cut first.

When the bone is sufficiently divided the limb is straightened, hemorrhage is arrested, and the treatment is the same as for fracture at this site.

The conditions which produce genu valgum may vary according to the figures shown in the cut.

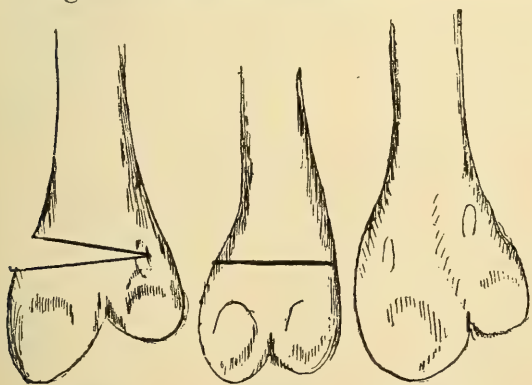


Fig. 47.

Fig. 48.

Fig. 49.

Figure 47 shows a section through about three-fifths of its diameter. Figure 48 shows the corrected position after the cutting. Figure 49 shows how the deformity is produced by an elongated external or internal condyle.

Bryant reports six hundred and fifty super-condyloid osteotomies. Of this number but three were reported as fatal, one from septicemia, one from hemorrhage and one from carbolic acid poisoning. In every other instance marked benefit followed the operation.

The following notations from Macewen's description of his operation of osteotomy for genu valgum are valuable. A sharp-pointed scalpel is introduced on the inside of the thigh at a point where a line drawn transversely a finger's breadth above the tip of the external condyle meets a longitudinal line drawn half an inch in front of the adductor magnus tendon. An incision is made at the union of these lines. The rule is

then observed as before suggested, of introducing the osteotome before the scalpel is withdrawn. In turning the osteotome so that the cutting edge is across the bone too much pressure must be avoided lest the periosteum be scraped off. The osteotome is now made to traverse over the surface of the bone till it has reached its posterior internal border. The cutting edge of the instrument is then applied and is driven into the femur forward and outward. In cutting on these lines there is no fear of injuring the femoral artery. The bone may be divided without paying heed to this order of procedure, but it is better that the operator should have a definite plan in mind so that he may be certain as to what is divided and what remains to be done. By means of the left hand, in which the osteotome is grasped, it should be given a slight movement of the blade after each blow of the mallet, longitudinally to its axis so as to prevent any tendency to fixity which it might assume. After the inner portion of the bone is divided a finer instrument may be slipped over the first, which is then withdrawn. A third may take the place of the second, if necessary, before the outer portion of the bone is divided. After a little experience the surgeon recognizes by touch and sound when the osteotome reaches the third layer on the outer part of the bone. If it be considered advisable to notch or penetrate this outer dense part of the bone in doing so the osteotome should be grasped firmly by the left hand as it is struck, a portion of the hand resting on the limb so as to check any impetus which might be considered too great. It is better to snap this layer rather than to cut it. When the bone has been sufficiently divided the osteotome is laid aside and a wiper saturated in an antiseptic solution is placed over the wound. While the surgeon holds the sponge he employs the hand as a fulcrum with the other grasping the limb lower down, using it as a lever, and, as the bone is hard or soft, it will either bend or snap, as the case may be, under his manipulation.

**Osteotomy for Genu Varum.**—Genu Varum is the deformity ordinarily known as bow-legs. (See Fig. 50.) Usually both legs are bowed out, the knees being widely separated, both the tibia and femur, as a rule, being curved and the feet turned in. The deformity is generally due to rickets, the weight of the body producing it in early life. In older people a similar condition may arise from arthritis deformans. If the case is not an exaggerated one and the bone is still pliable the treatment may consist of braces and plaster of Paris bandages. Attention to the general health of the patient is an important consideration. As bow-legged children are generally the victims of unsanitary surroundings, unwholesome food and uncleanly habits, much is accomplished by a change of these surroundings for fresh air, good food, and cleanliness. Genu Varum may depend on an outward curvature of the legs, wholly or in part.

The administration of the properly indicated remedy for struma or rickets will accomplish much. In the more exaggerated cases, particu-

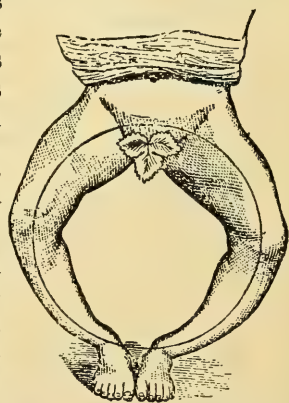


Fig. 50. Aggravated case of Genu Varum. (From Macewen.)



larly if the patient has reached adolescence, there are no means left for the successful correction of the deformity save by operation.

The deformity can occasionally be corrected by sub-cutaneous osteotomy. The tibia or fibula may be divided or broken or bent, as the case seems to require. I have seen equally good recoveries by simply bending the fibula after the tibia has been cut.

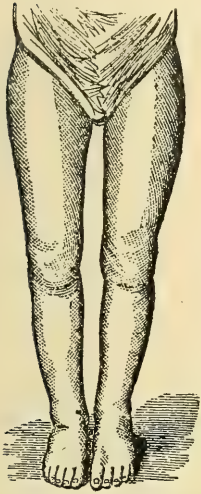


Fig. 51. Result after  
Osteotomy.  
(From Macewen.)

OPERATION. The site of operation should be rendered aseptic and the elastic bandage be applied. The limb is placed on a sand bag at the point of greatest curvature. This may be selected irrespective of other conditions. An incision is made down to but not through the periosteum. It is better to make this incision between the borders of the bone, so as to come upon its flat surface. The osteotome is introduced as in the other osteotomies and the tibia is divided as has been described for the fibula. The wound should be treated antiseptically and be closed throughout with sheep-gut sutures. A light antiseptic dressing is applied and the limb placed in a temporary dressing of splints and bandages until danger of hemorrhage and inflammation has subsided. This will generally require from three to five days. If all is then well the limb is placed in an immovable plaster of Paris dressing, which can be retained until union has

taken place. (See Fig. 51.)

One case operated on recently illustrated the methods and the results of the operation just described. A boy five years old had apparently recovered from rickets. Exaggerated bow-legs resulted, the bones being quite firm at the time of operation. An incision was made down to the tibia about midway between the knee and the ankle on the inner surface of the bone. The bone was trephined about three-fifths of the way through the tibia, cutting from the interior border outwardly and backward to keep the instrument near the center of the bone. In one leg the fibula was fractured in breaking the uncut portion of the tibia; in the other leg the tibia was broken and the fibula merely bent. Both legs were operated upon at the same sitting. They were dressed antiseptically and placed in splints for five days. Healing took place without inflammation. A plaster of Paris bandage was applied and kept in place for three weeks. Upon its removal the bones were found firmly united and the limbs very straight. A plaster of Paris bandage was again applied and allowed to remain two weeks, when it was removed and the child was allowed to go about as usual, and was able to bring the knees together without crossing the limbs.

After the bones are severed the condition is similar to that of compound fracture and must be treated on the principles which apply to that injury.

It occasionally happens that the bowing of the legs is due to a curvature both in the tibia and the femur. In such cases it is best to do two or three operations. At the first operation the tibia is divided as just described. When these bones have united thoroughly the femurs may be severed in a manner similar to that described for genu valgum. If it

is thought unwise to operate upon both of the femurs at one sitting a second operation can be delayed until union has taken place in the first. The results of osteotomies performed under antiseptic precautions are thoroughly satisfactory. Bryant reports that of fourteen hundred osteotomies but one per cent. were reported to have died in consequence.

**Hallux Valgus.**—Hallux valgus is a deformity of the great toe that is very frequently seen in subjects the victims of improperly fitted boots or shoes. The cut clearly shows this condition.



Fig. 52. Hallux Valgus.

The deformity may be very simple, requiring little or no treatment; or, again, it may be so great that nothing short of an operation on the bone will be of value. One of two methods may be undertaken. First, the removal of the head of the metatarsal bone with enough of the shaft to permit the great toe to be returned and held in its normal axis. This is a very simple operation and not at all dangerous when done under antiseptic precautions.

Second, a V shaped piece of bone may be removed from the inner portions of the distal extremity of the metatarsal bone as near the head as can be done without affecting the joint. An attachment is then made to the end of the toe and the deformity overcome by forcibly drawing the member inward. It may be necessary to fracture the bone to make it straight. This wedge-shaped piece of bone may be removed by means of a saw and chisel, in which case speedy union takes place with but little danger.

**Osteoplasty.**—So meagre are the reports and so indifferent are the results of transplantation of bone that for the present, at least, it must be regarded as in the experimental stage and each surgeon must work out its problems for himself. Certainly there is here a great field for experiment, as the necessity of the introduction of healthy bone to replace that of necrosis, caries or traumatism of large sections of bone often confronts the surgeon. Were it possible to successfully transplant bone a great many of the now necessary amputations could be averted.

## CHAPTER VI.

### ABSCESS OF BONE.

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**General Considerations.**—Abscesses of the bones have been studied since the time of Brodie; in fact they have been called Brodie's abscesses. They are, to a greater or less extent, a consequence of pre-existing osteitis. They are often the result of a bi-polar osteitis which has started and allowed the elimination of some pieces of bone while the other extremity suffered a lesser degree of inflammation without necrosis, but which left behind a source of irritation. This irritation in time becomes active, resulting in pus formation and bone abscess. These consequential effects may be observed even years after the original osteitis. The author recalls a case coming under his care, wherein the patient, when a boy, had typhoid fever which was followed by symptoms indicative of bone disease. There was an abscess which broke and discharged with partial recovery, only to return at a somewhat later period. In time, however, the diseased condition entirely disappeared, and aside from a slight irritation and stiffness of the knee-joint he grew to manhood. Twenty years after the original attack he presented a deep-seated swelling of the femur close to the knee-joint. An operation disclosed a bone abscess.

Ollier mentions a case of a man seventy-five years of age who had osteitis at the age of thirteen. He made two openings with a trephine, removed a bridge of bone between them with a gauge and found in the center of the bone a collection of pus in which was a small, longitudinal sequestrum. This had required more than half a century to become separated and to affect an appreciable inflammation around itself.

**Diagnosis.**—The diagnosis of bone abscess is not difficult as compared with general osteitis. There will be nightly exacerbations of fever, occasional chills and sweats, deep-seated pain of a throbbing character. There will be a gradual thickening of the bone and atrophy of the surrounding muscles. The skin assumes a glossy hue, a steady emaciation is quite generally observed and continues for months or years, as the case may be.

**Treatment.**—The treatment of bone abscess is the same as of abscess of the soft parts—thorough evacuation and drainage. The best guide for place of incision is the thickened portion of the bone, which indicates the inflammatory focus. The bone should be exposed freely along that portion which is thickened. There may be a little difficulty experienced in raising the periosteum owing to the presence of osteophytic excrescences. By holding the soft parts and periosteum out of the way with the Volkmann retractors opportunity is afforded for the use of a chisel to pare off the bone, layer after layer, until the cavity is reached. As there may be one or more communicating foci it is best to expose the medullary space the entire length of the thickening. The removal of the roof of this bone cavity converts it into a shallow trough



which allows thorough inspection and an opportunity for removal of all diseased tissue, which can be done by vigorous scraping with the sharp spoon, mopping with sponges and free irrigation.

As a last precaution, just before suturing a strong solution of bichloride (1 to 1,000) should be used to flush out the bone cavity to make sure of the total destruction of all lingering germs. The wound should not be packed if healing under moist blood-clot is expected, but should be sewed closely, except space for a small rubber drain at the lower angle of the wound. Under these skin flaps a blood-clot will join, which, if uncontaminated, will not suppurate but organize into healthy tissue. The line of incision should be covered with protective rubber tissue and that followed by many layers of sterilized gauze. The wound should not be dressed for three or four weeks if the cleanliness has been perfect.

**Bone Inflammation Due to the Presence of Parasites** (Actinomycosis).—Bollinger, a German veterinarian, discovered that certain tumors of the jaws in cattle were due to parasitic elements. He discovered in these tumors a peculiar fungus with a characteristic shape. The fungus is made of branching limbs, globe-shaped, and resting on a pedicle of varying height, presenting, on the whole, the appearance of an irregular umbel. The gravity of this affection depends upon the propagation of the parasite by the channels of the circulation. It may infect the lung and then spread in different regions. Its course is chronic, although giving rise to acute symptoms. If the disease be discovered in the beginning it is possible to remove all the parasitic elements from the jaw, or the affected region. Even resection may be necessary. What the origin of this fungus may be is not definitely known as yet. It is probably derived from vegetables which both animals and men use for nourishment. Its contagiousness has been demonstrated by Ribolta. In cattle this disease is known as lumpy-jaw.

**OPERATIVE TREATMENT.** The only treatment available is absolute extermination by operation. If the surgeon keeps before him the fact that bone should be treated essentially like the soft parts his course will be more clearly defined. When inflammation first shows itself, it should be the endeavor to avert it and prevent the formation of pus. When pus has formed it should be evacuated at the earliest possible moment. Incision is the only reasonable way of accomplishing this. This principle holds good whether the pus be under the periosteum or in the medullar canal; therefore there is no need to outline one treatment for periostitis and another treatment for osteitis or endo-osteitis. As there are different degrees of osteitis, so should treatment be subordinated to these varying degrees. There are those mild forms which might be treated by rest, cupping, and internal medication; there are others, especially infective osteitis, which, in spite of all the best measures employed, will be attended with suppuration. If there be a gnawing, deep-seated pain and fever, the surgeon should not wait for swelling but act vigorously, using the knife and trephine thoroughly. He should not wait too long for palliative measures but proceed to meet the inflammatory focus, not waiting for this focus to come to him. With all due respect to conservatism it is safe to say that when the diagnosis of periostitis or osteomyelitis is made an incision should be made to the bone

and if necessary it should be trephined. While it is rare that harm will be done by any such measure it is quite to be expected that more destruction of tissue will follow by conservatism. Strangulation of the medullary canal calls for as imperative treatment as does strangulation of the intestines.

## CHAPTER VII.

### TUBERCULOSIS OF BONE.

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**Nature.**—Senn, in “Tuberculosis of Bones and Joints,” says: “For centuries, most of the chronic inflammatory affections of bones have almost by common consent been recorded as a local manifestation of a general dyscrasia, which, for want of a better knowledge was called scrofula. Some of the text-books even at the present time continue to discuss the subject of strumous disease of bones and joints. Others, prominent among them Sayre, of New York and Bauer, of St. Louis, assign to struma the principal role in the production of the inflammation. Ignoring the action of a more subtle class I will now enumerate the most important evidences which tend to establish the fact that diseases of bones and joints, heretofore regarded as scrofulous or strumous in their origin, or the product of a chronic inflammation following an injury are tubercular in their origin, and clinical tendencies and the inflammatory product present histological appearances which are identical with the tissue lesions found in pulmonary and other well recognized forms of tuberculosis in other organs.”

**Presence of Tubercle Bacilli.**—Tubercles are only found in the body in connection with tubercular affections; and their constant presence in the joint and bone affections now under consideration furnishes a strong proof of the tubercular nature of the lesions. Koch, Krause, Schuchardt and Cheyne have repeatedly succeeded in demonstrating the presence of tubercle bacilli in fungous disease of bones and joints. Koch gives the result of his examination of thirteen specimens of bone and joint tuberculosis. He found tubercle bacilli within giant cells, and, between, epitheloid cells and the cheesy material in all of them except one, this a case of tubercular abscess of the vertebræ in which no bacilli could be found in the pus; inoculation experiments, however, yielded positive results.

Castro-Soffia was one of the first to make a careful, methodical search for the bacillus in tubercular lesions of the bone. As the result of quite an extensive clinical investigation he assures us that he never failed in demonstrating the presence of the microbe by microscopical examination and also by inoculation experiments.

In this connection it is well to mention incidentally that Schuchardt and Krause have examined specimens from forty cases of surgical tuberculosis in the clinics at Halle and Breslau, comprising synovial tuberculosis, ten cases; osseous tuberculosis, three cases; glandular tuberculosis, three cases; cold abscesses, fourteen cases; tubercle of muscle, one case; tubercle of tongue, one case; tubercle of testicle, one case; tubercle of female genitalia, one case; miscellaneous, six cases; total, forty cases.

In every one of these they found the characteristic bacilli. Schleg-tendal examined five hundred and twenty specimens of pus from tubercular abscesses and found bacilli present in about seventy-five per cent. of



the cases. As the bacilli are never as numerous in tubercular pus as in granulation tissue there can be but little doubt that in the remaining twenty-five per cent. of the cases they were present but not discovered; or perhaps, that in some of them the primary lesion was not of a tubercular nature. Experiments have repeatedly shown that pus from tubercular lesions in which no bacilli could be found, produced, when injected into the tissue of animals susceptible to inoculation, typical tuberculosis—a positive demonstration that the material injected contained the essential cause of the disease.

W. Mueller has learned from experiments in the examination of numerous specimens of tuberculosis of bones and joints that it is very difficult to find the tubercle bacilli in some of them. In about twenty-five specimens he failed to find them; nevertheless, he believes that they were tubercular and that the bacilli were so few in number that their detection was difficult or that they were not properly stained. In many of the specimens he found masses resembling drops of fat surrounded by fine granulations which could be deeply stained with methyl-violet, and expressed the opinion that these bodies were fragments or parts of bacilli, capable of producing the disease in animals by inoculation.

Mogling found the bacilli never absent from tubercular pus in fifty-three patients. Among others who have shown the never-failing presence of the bacillus in different forms of surgical tuberculosis, including bones and joints, may be mentioned Kanzler, Bouilly and Letulle.

Tuberculosis of bone, and fungous disease of the joints, like lymphatic tuberculosis, have been and by some are still regarded as scrofulous affections. Kanzler makes a distinction between scrofula and tuberculosis. He found bacilli not as constant in the former and observed that after implantation of tissue of what he regarded as scrofulous affections in animals the process was slower than after inoculations with the products of recognized forms of tuberculosis. Letulle considers scrofula and tuberculosis as belonging to one and the same disease, of which the former constitutes the milder form and appearing externally, while the latter represents the graver form, taking by preference the internal organs. The points made by the last two authors are too unimportant for further consideration as a scientific or even pure distinction between scrofula and tuberculosis as applied to affections of the bones and joints. The surgeon must recognize every lesion as tubercular in its origin under a course in which the bacillus of tuberculosis can be found from which successful cultivations can be made and with which the disease can be artificially produced in animals by inoculation. Watson Cheyne asserts, as the result of his numerous experiments, that bacilli can always be found in the tissue lesions, but in most cases they were extremely few in number. He believes that the difficulty in finding them more constantly and in greater number is owing to our present defective means for staining.

**Direct Infection.**—There can no longer be a question of doubt that tubercular virus may enter into a bone or joint through a penetrating wound. In the *Fortschritte Der Medicin*, 1886, there is a report of a case of a healthy carpenter who opened his knee-joint by the cut of an axe, dressing the wound with a soiled handkerchief. The wound healed kindly, but became inflamed, tender and painful. Resection was performed, and on examining the capsule it was found very much thickened.

In the granulation-tissue bacilli were found. Pfifer reports a case wherein a veterinary surgeon punctured his thumb while dissecting a tubercular cow. The wound healed, but the joint became the seat of tubercular inflammation. Eventually, pulmonary phthisis set in, the patient succumbing a year and a half after the injury. The joint showed a typical tubercular disease.

The implantation of fragments of tubercular synovial membrane into sub-cutaneous tissue or peritoneal cavity of animals susceptible to tuberculosis almost without exception reproduces the disease in the animal. It is a well recognized fact that a large quantity of tubercular material, or the bacilli, may be injected into healthy tissues without producing tubercular disease, which shows that healthy tissues are capable of disposing of a large quantity of this tubercular virus, but that when once reduced in vitality they become a prey to the tubercular bacilli. That bone tuberculosis does give rise to tuberculosis in other joints is so evident that a direct etiological relationship between the primary and secondary affection must be recognized.

Neumeister has collected four hundred and thirty-eight cases of tuberculosis of bones in joints from the Wurzburg clinics with fifteen per cent. of deaths from acute tuberculosis. Rokitansky, Virchow, Koster and others have shown that the primary nodules in bone membrane during the early stages of tubercular disease show under the microscope the same structure as milliary tubercle in the lungs. The primary inflammatory focus is a tubercle in which the same histological elements can be found arranged in the same manner as in milliary tuberculosis of the lung.

Tuberculosis in bones and joints, as in other organs, presents in two forms—either as a medullary product or tubercular inflammation, and both forms are often seen in the same specimen. In the tissues varied or epithelioid cells are not collected in small masses, but are located throughout the other tissues irregularly. The primary tubercular nodule shows the presence of leucocytes, giant-cells, epithelioid-cells and reticulum. When the bacillus tuberculosis finds lodgment in a bone it first produces inflammation, which invariably results in the production of granular tissue. The surrounding healthy tissue is protected by the embryonal cells; these embryonal cells show early tendency to undergo degenerative changes. Then there follow coagulation, caseation and liquefaction of the cheesy material into an emulsion. This has been ordinarily regarded as pus, but it is, properly speaking, the product of retrograde tissue-metamorphosis.

**Symptoms of Bone Tuberculosis.**—This has been given the old name of cold abscess because it lacks the phenomena which attend the development of an acute or inflammatory abscess. There is scarcely any rise of local temperature and the skin looks rather pale than red. The abscess itself is painless and not tender to pressure. Fluctuations may be discovered early, as there is little inflammation or induration of the tissues round about. All of these symptoms are markedly in contrast with the acute, inflammatory abscess. It differs again from the acute abscess by virtue of its tendency to migrate from the place where it originated to distant localities by gravitation. This is best seen in the lumbar abscess, which may follow the iliac muscles and appear in one of

the iliac regions, being thus termed the iliac-psoas abscess. The tubercular abscess of the hip joint is another example of its migratory character. This migration of the fluid contents of the abscess causes an infection of the tissue along the course traveled by the abscess, which latter is always lined with infected granulation tissue. Senn mentions a case of a large tubercular abscess of the iliac fossa which formed in the course of two weeks by extirpation of a tubercular testicle. There is generally a chronic inflammation of the glands preceding the formation of a tubercular abscess. The fluid removed from this abscess presents the appearance of serum in which minute particles of broken-down tissue are to be seen, while in an abscess caused by mixed infection it presents the microscopical appearance of true pus.

**Treatment.**—Tubercular abscess of bone should be treated in similar manner as the non-tubercular abscess, only there should be a more thorough eradication of the disease by the injection of the surrounding parts with some antiseptic solution, or what is called sub-cutaneous iodiformization. According to Billroth the bones which are more particularly liable to tuberculosis are arranged in the following order: The vertebræ and femur, cranium, face, sternum and ribs, foot, humerus and pelvic bones, fibula and tibia.



SECTION X.  
DISEASES AND INJURIES OF JOINTS.

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CHAPTER I.  
GENERAL CONSIDERATIONS.

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**Anatomy of a Joint.**—For a proper understanding of diseased conditions of a joint the most essential factor is a recognition of the structures entering into its formation. From the standpoint of a surgeon a joint consists of four parts: (1) The synovial membrane, (2) the ligaments, (3) the encrusting cartilage and (4) the bone.

**Synovial Membrane.**—This is the lining membrane of the joint cavity and is similar in structure to other serous membranes. It lines the inner surface of the surrounding ligaments and is reflected from them on to the articular ends of the bones. It does not cover the encrusting cartilage but is attached to their margins. In those joints containing intra-articular ligaments and cartilages the synovial membrane completely surrounds these structures on all sides, so that while they are in a sense intra-articular they are not strictly within the joint cavity. The function of the synovial membrane is to secrete a lubricating fluid to lessen the friction. This membrane is freely supplied with blood-vessels, nerves and lymphatics, though the slowness with which effusions are absorbed would indicate that the lymphatics are neither so numerous nor so active as in other serous membranes.

**Ligaments.**—These are the firm fibrous structures that bind the articular ends of the bones to one another. For practical purposes they may be regarded as the outer investments of the synovial membrane, the two are so intimately blended. In truth they constitute the joint capsule, though in some parts of the body certain ligaments remain distinct even in diseased conditions. The intimate relationship, however, is of the utmost importance pathologically, for disease beginning in one structure can readily involve the others by extension. It is this firm ligamentous envelope that maintains the conformation of the joint. This explains how joint effusions at first assuming the shape of the synovial membrane later may become globular in outline as the ligaments become softened and yielding.

**Encrusting or Articular Cartilage.**—This is a thin layer of hyaline cartilage covering the articular ends of the bone. In health this cartilage is non-vascular and depends for its nourishment upon the underlying bone and the synovial membrane attached to its margins. In disease of an inflammatory type blood-vessels may be seen shooting in from

the marginal synovial membrane, and even vascular granulations are found developing there. Anatomists have as yet been unable to trace nerves into cartilage; so the extreme pain incident to ulceration of these tissues must be due to the exposure of the underlying bone. From its imperfect nutritive supply, depending entirely as it does upon absorption from contiguous structures, it may be easily understood that cartilage would be but feebly resistant to pathological influences, whether arising in the synovial membrane or in the subjacent bone.

**Articular Ends of the Bone.**—These consist of cancellous or spongy tissue with a thin covering of compact tissue. They are supplied by the articular arteries, which up to the time of epiphyseal union do not anastomose with the arteries of the periosteum nor with the nutrient arteries of the shaft. It is of the utmost importance to remember that until the eighteenth to twentieth year the ends of the bone are absolutely separated from the shaft, not only by the epiphyseal cartilage but by the firm attachment of the periosteum to this cartilage. This explains the infrequency of the extension of disease from one part to the other in early life. The arrangement of the veins in this spongy bone is peculiar and important, their very anatomy predisposing to the localization of disease. Their walls are extremely thin and are firmly attached to the bony canals through which they are distributed. On this account they can not collapse when ruptured, and very slight traumatism is sufficient to damage the thin endothelial lining and thus give rise to thrombosis and the localization of floating micro-organisms.

**Etiology and Classification of Joint Diseases.**—The causes of the surgical affections of joints may be considered under three headings: (1) Traumatism; (2) Inflammations; (3) Abnormal Nutrition.

**TRAUMATISM.** This is the most active agent in the causation of diseases of joints, for it acts not only by its direct destructive influence but also serves as a localizing factor in the inflammatory group and may be the indirect cause of nutritive changes through injury to the supplying nerves.

**INFLAMMATION.** Of inflammations of joints, as of any other structure, there are two kinds—the acute and the chronic, and two varieties of each kind—the simple and the infective.

Inflammation may attack any one of the anatomical structures named as entering into the formation of joints, but is especially prone to attack primarily the most vascular parts, i. e., the synovial membrane and the bone. Thus, when one structure only is involved there may be synovitis or osteitis; but when two or more structures are diseased the affection is termed arthritis.

Simple inflammation, as a rule, is the result of direct injury, such as a strain, a contusion, or a penetrating wound. It may also arise, especially in joints that have been previously diseased, from exposure to cold. The disease is really the traumatic reaction of the damaged tissue, and if secondary infection does not take place shows no tendency to spread beyond the area of injury.

Infective inflammations are always the result of localization and development of infective micro-organisms. These may be introduced directly through a wound; or traumatism may induce the localization of microbes

which are in the circulation; or, without traumatism, such circulating germs are deposited in tissues the seat of previous pathological changes. Invasion also occurs by direct extension from adjacent structures or as a pyemic or embolic process.

**ABNORMAL NUTRITION.** Abnormal nutritive changes are usually secondary to nerve disease or injury and are trophic in character. They may be distinctly localized by direct nerve injury, or be general, as the result of spinal disease. The result is invariably ankylosis, either partial or complete, and atrophy or irregular hypertrophy of the joint tissues.

**Classification.**—The traumatic diseases of joints or sprains, contusions and penetrating wounds. The inflammatory diseases of joints are acute serous synovitis, suppurative synovitis, arthritis, gouty arthritis, acute rheumatic arthritis, chronic serous synovitis, syphilitic arthritis, chronic rheumatic arthritis, osteo-arthritis, (arthritis deformans, neuropathic arthritis), tubercular arthritis.



## CHAPTER II.

### TRAUMATIC DISEASES OF JOINTS.

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**Sprains.**—A sprain is a stretching, laceration or rupture of the ligaments of a joint, the articular surfaces not being displaced. In other words, a dislocation minus the displacement of bones. The cause is always a mechanical strain—such as a sudden wrench when the muscles are off guard, or a hyperflexion or extension—as in some athletic effort.

**PATHOLOGY.** This obviously depends upon the severity of the injury and varies from a stretching of the ligaments to a complete rupture of the synovial membrane, the capsular and other ligaments of the joints. Even the tendinous insertions of muscles, or the muscles themselves, may be ruptured and the tendon sheaths, as well as the synovial cavity and the surrounding connective tissue-spaces, become filled with the effused blood or later with serum and cells.

**SYMPTOMS.** The most frequent symptom is sudden and extreme pain immediately upon receipt of the injury, with partial or total disability. In very severe cases swelling comes immediately, the synovial cavity being greatly distended in a few moments. (Hemarthrosis.) In those less severe it may not reach an extreme degree for several hours and is then due largely to serous exudate. The parts are tender even to slight touch or movement, especially to those movements which put the torn ligaments upon a stretch. As the effused blood approaches the surface varying degrees of discoloration are apparent and extend far beyond the area of greatest injury, at times up to the next higher joint.

**DIAGNOSIS.** This is not difficult if seen before extreme swelling has occurred; but when the effusion is very great, and from the nature of the accident a fracture is suspected, it is safer to anesthetize the patient in order to make a thorough examination. In event of refusal, diagnosis should be withheld until the swelling subsides. The absence of gross deformity and the less marked fixation of the parts will usually enable a differentiation from dislocations.

**TREATMENT.** This may be summed up in three words—rest, elevation and heat. Many surgeons recommend the cold applications, but clinically heat has served the author much better, not only in the relief of pain but also in the prevention of inflammation and in hastening resolution. The limb should be completely submerged in water as hot as can be borne for from thirty minutes to one hour, the temperature being evenly maintained. This bath should be repeated at intervals during the first two or three days if the after-elevation and hot moist dressings are not sufficient to allay the pain. After the extreme tenderness has subsided the heat should be replaced by pressure. The pressure must be uniform and steady, and is at first best supplied—the injured part being still elevated—by means of elastic wool compresses and a flannel bandage. With the resulting improvement this will be succeeded by a rubber bandage, and when the effusion is practically absorbed, a starch bandage or a plaster cast should maintain fixation until the torn ligaments have

had a chance to unite. Passive movements begun early can only be productive of harm. After the tissues have had time to heal, massage, electricity, passive, and, above all, active movements, avoiding severe pain, will serve as preventives of ankylosis.

**RESULTS.** Patients with severe sprains should not be allowed to go about too early. From three to six weeks should be well spent in recovering from such injuries. The dangers are ankylosis, either partial or complete; the localization of some constitutional taint, such as rheumatism, and a weakened joint which a slight irregularity of movement will tend to inflame. All of these serious after-effects may always be modified, if not altogether prevented, by avoiding the too early use of the joint.

**Contusions of Joints.**—These vary from slight bruises to severe crushing injuries, but as the latter are treated of elsewhere (comminuted and complicated fractures) description is here limited to those cases uncomplicated by fracture. The cause is always direct injury, such as a fall upon a joint, a kick, or a direct blow from a club or ball.

**PATHOLOGICAL CONDITIONS.** These may be limited to an extra-capsular effusion of blood, and, later, a cellular infiltration of the damaged parts, or a hemorrhage or serous effusion into the joint similar to that accompanying a severe strain.

**TREATMENT.** The treatment is practically the same as that recommended for sprains; the watchwords rest, elevation and heat serving as the best agents in securing the three objects of attainment, viz: (a) the prevention of the inflammation, (b) the absorption of the exudate and (c) the functional restoration of the part. Too much emphasis cannot be laid on the importance of the strictest adherence to antiseptic methods in the prevention of bad after-effects in those cases where an abrasion exists, no matter how insignificant it may be in size.

**RESULTS.** The results are almost uniformly good where secondary infection is prevented. The greatest dangers are: (1) The localization of infective inflammation either from the direct introduction of infected matters or from the localization in the bone or joint-cavity of circulating micro-organisms; (2) suppuration and destruction of the extra-articular tissues with cicatricial contraction and consequent impaired mobility and deformity of the joint; (3) ankylosis either from intra or extra-articular disease (fibrinous deposits).

**Penetrating Wounds of Joints.**—These injuries are not infrequent in mechanics, as from the slipping of a screw-driver or an awl, but are met most commonly as the result of stabs and shot-wounds. The extent of injury varies from a simple puncture to an extensive comminution of the articular bones.

**TREATMENT.** In those penetrating wounds from sharp instruments the chief danger is infection, and careful inquiry should be made as to the character and condition of the instrument inflicting the injury. If a bright, polished instrument, if the wound is small, clean-cut and not lacerated and if the escape of synovial fluid is not excessive the wound and the surrounding parts should only be thoroughly cleansed and sterilized. A few strands of swollen sheep-gut are to be inserted within the opening for drainage, an ample, moist antiseptic dressing applied, the injured joint elevated and kept at perfect rest. When the wound is large and lacerated, and there has been a free escape of synovial fluid, or when the in

strument inflicting the injury is dirty or is known to be septic, or when the treatment above advised is followed by inflammation of an infective nature, the original wound should be enlarged, the lacerated tissue removed, a counter-opening made on the opposite side of the joint, so as to thoroughly drain the whole joint cavity, and the parts freely washed with a continuous stream of some reliable antiseptic solution. It is better in all such cases to apply an elastic constrictor not only to avoid hemorrhage but also to prevent absorption of the germicidal lotion, which, to be of real service, must be used in large quantities, the joint being moved freely during the irrigation, thus bringing every crevice in the synovial membrane into direct contact with the lotion. After a final douching with a sterilized salt solution large tubular drains should be inserted and an abundant hygroscopic dressing applied.

Shot-wounds of joints may possibly be simple penetrating wounds, but there is usually a splintering of one or more of the articulating bones, i. e., a compound comminuted and complicated fracture which endangers the mobility of the limb. The treatment does not differ especially from similar injuries due to other causes. As Esmarch says, "the damage done by a bullet is in its passage, the harm that is added comes mostly from the examiner's probe or finger." The keynote to the successful treatment is the prevention of infective inflammation.

If the soft tissues only are involved, if from the nature of the wound, the distance from which the shot was fired and the condition of the overlying clothing the surgeon is satisfied that no foreign body other than the bullet has gained entrance, the wound and the surrounding parts are to be thoroughly cleansed, rendering them perfectly aseptic, after which drainage is provided; if there is escape of synovial fluid or a marked oozing of blood a large antiseptic dressing is applied and the limb put at complete rest in splints.

The conditions demanding thorough exploration of such a shot-injury are: (1) The presence of foreign bodies other than the bullet, as shreds of clothing, wadding etc., (2) previous examinations without antiseptic precautions, (3) an extensive laceration of the soft tissues, comminution of the bone or section of important blood-vessels or nerves, (4) infective inflammations already begun.

In dealing with such conditions the preparation must be complete, the operation thorough. The opening must be sufficiently enlarged to permit of satisfactory exploration, all foreign bodies—hopelessly lacerated or bruised tissues and detached fragments of bone—are to be removed, severed nerves sutured, ruptured blood-vessels ligated and the comminuted bone moulded as nearly as possible into its normal form. Adequate drainage should be provided, and after being assured of perfect sterilization the wound may be sutured, dressed and immobilized. The damage may be so great that amputation or resection may be deemed advisable in all cases of extensive destruction of tissue; especially when the main supplying artery has been severed these questions must be earnestly considered. If the disturbance to the circulation is great, if there has been marked periosteal detachment and, above all, if infective inflammation has already started amputation is to be preferred to excision.



### CHAPTER III.

## INFLAMMATION OF THE JOINTS.

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**Acute Serous Synovitis.**—This is an acute simple inflammation involving primarily the synovial membrane.

**ETIOLOGY.** Most of these cases are directly traceable to traumatism in some form, as strains, twists, contusions or penetrating wounds made with clean instruments. Chilling the parts, especially in joints the seat of former inflammation, is a frequent cause.

**PATHOLOGY.** The anatomical changes begin as an active hyperemia, the rapidity of the circulation being markedly increased. In traumatic cases this may have been preceded by sub-synovial or intra-synovial hemorrhages, according to the nature and severity of the injury. As the blood-vessels become still more widely dilated the onward flow slackens and the parts appear dark and swollen, the change from the normal being as from satin to velvet. This swelling is due in part to the dilated blood-vessels and in part to the exudate of leucocytes and serum, which find their way not only into the tissues but also into the joint, distending it with the characteristic serous or sero-fibrinous fluid. The further changes depend upon the activity of the process and the treatment instituted. If left alone the parts most damaged become so infiltrated with the cellular exudate that in its coagulation the nourishment is practically cut off and the endothelial cells begin to soften, break down and fall into the distended cavity. The destructive changes are not apt to progress further unless infection results, but where there are large or small denuded pieces the endothelium is replaced by a fibrinous deposit which, according to its extent, may simply give the “creaking” noise upon movement, or, from adhesions to opposing surfaces, result in ankylosis. Under treatment the distended vessels contract and resume their natural calibre and the exudate is absorbed before denudation of the surface occurs.

**SYMPTOMS.** Shortly after the accident the joint becomes swollen, the swelling increasing rapidly and reaching its maximum in a few hours, when fluctuation is easily elicited. There is constant pain, markedly aggravated by movement in any direction, the joint being hotter than the surrounding parts and tender to pressure. Acute redness is seldom seen in this form, the area of active hyperemia being in the sub-cutaneous tissues. The constitutional symptoms are slight if present at all.

**PROGNOSIS.** This, of course, depends upon the cause, the extent of the injury and the time that elapses before the case comes under the surgeon's care. In ordinary cases seen early the progress is toward a speedy recovery with perfect restoration of function. The tendency to recurrence must always be remembered and the patient cautioned against a too early return to business.

**TREATMENT.** If the patient is seen during the active hyperemia which precedes the true inflammation the cold bath, continuous irrigation with cold water or the constant current through the litre tube will

usually be successful in preventing inflammation to any great extent. Too much emphasis cannot be laid upon the necessity of the early and continuous application of cold in order that its best effects be apparent. Applied later—at the time surgeons are usually called—when the inflammatory exudate has already begun, cold is not only useless but actually harmful. Continuous moist heat is our most reliable agent and is useful in preventing the complete stasis which results in the denuding of the synovial endothelium. The limb should usually be flexed and elevated, which is the position most comfortable to the patient. The heat may be maintained by compresses, frequently changed, by complete submersion, or by wrapping the joint in moist compresses, covered with a piece of pure rubber tissue or oil-silk, and by surrounding the joint with hot water bags. Aspiration is seldom called for, but in event of extreme distension may be done harmlessly by attention to antiseptic details; it should be followed by further elevation, heat, and moderate compression. After the inflammation has ceased the absorption of the exudate is best hastened by uniform pressure and massage.

The remedies most commonly of service are bryonia, ferrum phosphoricum, arnica and belladonna during the active process. Later, for the absorption of the exudate, sulphur is required.

**Acute Suppuration, Synovitis and Arthritis.**—This is an acute infective inflammation of the synovial membrane or of all the joint structures.

**ETIOLOGY.** The suppurative form may be engrafted upon a synovitis primarily serous in character. It may be due to the direct introduction of infective matter through a wound, or to indirect infection as in the localization of micro-organisms in the circulation during the process of an infective disease—such as scarlatina, typhoid fever, pneumonia, diphtheria, dysentery, etc.

The extension of inflammation from some adjacent tissues and metastatic or pyemic involvement during suppuration of some distant focus are also among the frequent causes, the one essential factor being the localization and development of pyogenic micro-organisms.

**PATHOLOGY.** The anatomical changes begin in the same way as the serous form—with an active hyperemia. The disease extends rapidly, passing through the different stages until complete stasis is produced. Owing to the more active and rapid process the inflammatory exudate is more pronounced, and as coagulation-necrosis takes place areas of considerable extent of the synovial and sub-synovial tissues are deprived of nourishment and easily liquefied by the peptonizing action of the pus-microbes and their products. In this way the pus cells, the liquefied fibrin and the fat globules are added to the serous and corpuscular exudate to form the pus which distends the synovial cavity. As the disease extends and the capsule and ligaments become infiltrated the area of active hyperemia approaches nearer and nearer to the surface. This accounts for the well-defined redness and also for the sub-cutaneous edema. If the process is not allayed the capsule and ligaments become softened and break down, the cartilages no longer glisten, but are dull and sodden. Newly developed vessels extend over them from the attached margins of the synovial membrane. The synovitis has become an arthritis. The further course depends upon treatment. If unchecked the inflammation

still extends, causing either the complete destruction of the encrusting cartilage or its separation from the underlying bone. In either case the bone becomes involved in a suppurative osteo-myelitis, peri-articular abscesses form and may follow along the inter-muscular spaces or rupture externally, leaving sinuses through which putrefactive contamination may take place.

**SYMPTOMS.** The disease may be primary or secondary and the initial symptoms vary accordingly. If secondary to a serous synovitis there is, in addition to the clinical history above described, the development of a more angry inflammation. This change is usually rapid but not sudden, the condition progressing from bad to worse until a typical pyo-arthritis is developed. In those cases developing during an acute infectious disease, or manifestly pyemic in character, the onset is sudden. It may be ushered in with a chill or a succession of chills, and when a large joint is involved the temperature rapidly rises to 104 or even 105 degrees F. With this fever there is a corresponding increase in the rapidity of the pulse, which is at first full and bounding but soon loses its volume. If the suppuration is allowed to continue the patient may drift into an acute septicemic or pyemic condition and die within a few days. The local conditions are very characteristic. The distended joint is very hot, bright red and exquisitely tender and painful. The pain is aggravated by the slightest movement or even by the jar caused by someone's walking across the room or touching the bed. The swelling is at first distinctly outlined by the synovial membrane and fluctuation is, as a rule, readily elicited; but as the disease extends and involves the capsule and ligaments the peri-articular tissue and even the whole limb becomes swollen and edematous. The bright redness then changes to a dusky red or even a bluish purple or mottled appearance and to the steady pain is added the "starting pains," especially at night, showing erosions of the cartilages. Spontaneous luxation, owing to the softened conditions of the ligaments, is not infrequent. If the patient survives the blood-poisoning, the purulent collection when left undisturbed will burrow along the connective tissue planes and fasciæ and finally approach the surface and evacuate itself. The relief of tension is followed by relief of the severe symptoms, but unless the drainage is adequate this is but temporary, the patient drifting into the so-termed hectic condition, becoming markedly emaciated and dying from exhaustion.

**PROGNOSIS.** With an early diagnosis and energetic surgical treatment complete restoration can usually be brought about. When marked destructive changes have occurred, as in the neglected cases, a fibrous ankylosis is as much as can be expected, and in the worst cases even amputation may not save the life of the patient.

**TREATMENT.** The earlier treatment is instituted the greater the certainty of complete cure and the restoration of perfect function. The practice of temporizing with local applications of any nature after suppuration has begun can not be too strongly condemned. If pus is suspected but not known to be present exploration with a hypodermic needle is demanded. When proven to be present the parts should be prepared as for any antiseptic operation, the patient anesthetized and a free incision made into the joint cavity. The incision should be so directed that subsequent cicatrization will not interfere with joint movements. Counter-openings must



be made, if necessary, to insure perfect drainage, the parts being meanwhile continuously washed with some reliable antiseptic solution. Drainage tubes are then to be inserted and secured, a large antiseptic dressing applied and the joint placed at rest. In cases taken early, when the synovial membrane alone is involved, the above treatment followed by daily irrigation and the passive movement, until suppuration ceases, will usually result satisfactorily. In neglected cases of arthritis, where there is evidence of involvement of the peri-articular tissues with destruction of cartilages and extension of the inflammation to the bones, more radical measures are indicated. The joint should then be laid open freely so as to expose the entire cavity for inspection. After noting the extent of the disease the surgeon must carefully select the measures which will offer the best chances for recovery with the most useful limb. The lines of incision as well as the choice between arthrectomy, excision and amputation will be considered in the chapter devoted to operations on joints. Synovial effusions secondary to the acute infectious fevers and to gonorrhea or gleet, the misnamed gonorrheal rheumatism, are not always of a purulent character, indeed seldom so unless there is a mixed infection. In such cases, particularly if the onset is insidious, aseptic aspiration should always be performed before advising operative measures. Where the effusion is serous or even sero-purulent the aspiration and subsequent thorough washing with a four per cent. solution of boracic acid or a three per cent. solution of carbolic acid will usually effect a cure, though this may have to be repeated two or even three times before resolution takes place.

**Gouty Arthritis.**—This is an acute inflammation of joints occurring in lithemia. It affects men more often than women and is more frequent after the age of forty than before. For a full description of this disease the reader must consult a work on the practice of medicine.

**CAUSES.** There seems, undoubtedly, to be an hereditary tendency to the affliction, but most of the cases can be traced to errors in diet, such as the too free use of malt liquors and especially to a too exclusive use of the animal foods with little outdoor exercise. There may be at times so decided a functional hepatic derangement that even a small quantity of animal food will give the uric acid necessary to precipitate an attack.

**SYMPTOMS.** There are two well-defined forms, the acute and the chronic, the latter being the result of repeated attacks of the acute form. Acute gouty arthritis usually comes on very suddenly, nearly always at night, and attacks, by preference, small joints which have been previously diseased or injured. The metatarso-phalangeal joint of the great toe is the most common locality because that joint is so frequently irritated by ill-fitting boots. It becomes red, swollen, hot, very painful and so sensitive that even the weight of the bed-clothes can hardly be borne. There are usually some febrile symptoms, the severity depending upon the acuteness of the attack and the number of joints affected. The pain is paroxysmal in character, becomes less intense in the morning but recurs the following night with the same or added virulence. After a few days the swelling begins to subside, the pains lessen and the exudate becomes absorbed. Such attacks are usually followed by some desquamation of the cuticle. In chronic gout the attacks are frequent and last longer than in the acute form. The same symptoms are present but are less

intense and agonizing. The joints are swollen but irregularly so, the deposits of former attacks having never become entirely absorbed. Several joints are usually involved, and even after the acute exacerbation has passed they remain enlarged, misshapen and stiffened, and the skin over them is tense and glossy. Each succeeding attack leaves the joints more deformed and less mobile, until both hands and feet are pitiful disfigurements.

**PATHOLOGY.** The keynote to the pathological condition is the excess of uric acid in the blood and the deposit of its salts (especially the urate of sodium) in and about the involved joints. The presence of this foreign body excites the inflammation, which in the early attacks is clinically a serous synovitis. With the repetition of the attacks the deposit in the cartilages causes the inflammation, softening, and even the absorption of the cartilage. The exposed articular bones undergo a like transformation until the original shape is entirely altered by irregular outgrowths or nodules. The tendons and ligaments are also infiltrated and altered in character. At times masses of these urates of sodium, calcium and ammonium are deposited as well-defined concretions (tophi) in the peri-articular structures. The localization of suppuration in gouty joints is very rare but does occur sometimes as the result of the continual irritation of these gouty concretions. The successful treatment of gouty arthritis is preventive, and depends upon a recognition of causes and their removal where possible, an entire revolution in the diet and mode of life, systematic outdoor exercise, to assist in the oxygenation of such nitrogenous matter as the patient may be allowed to eat, and medicines to assist in the solution and elimination of uric acid and the salts. The measures are strictly medical and have no place here. The local treatment should be similar to that recommended for acute serous synovitis, especial attention being devoted to massage to hasten the absorption of the exudate and prevent deforming contractions.

**Acute Rheumatic Arthritis.**—The belief that rheumatism is an infective inflammation due to the direct action of a specific microbe is rapidly gaining ground. In the absence of positive proof, however, it must be still regarded as a strictly medical disease, and finds a place in the text-books on surgery more for the sake of comparative diagnosis than for any special surgical interest. Rheumatic arthritis begins as a synovial inflammation, the capsule, ligaments, and cartilages becoming involved secondarily. The most frequent exciting cause given is exposure to cold and dampness. It is especially prone to attack young adults who are run down by other illnesses or by overwork. It is seldom mon-articular usually involving several joints, either simultaneously or in rapid succession. They become swollen, hot and tender on pressure and the skin is more or less red and tense. The large joints are usually involved, the inflammation travelling from one to another with surprising rapidity. The temperature ranges from 101 to 103 degrees F., though if many joints be involved it may even reach 105 or 106 F., the pulse being correspondingly rapid, while the characteristic symptom is the profuse sour-smelling perspiration. The urine, too, is exceedingly acid, scanty, high-colored and loaded with urates and uric acid. The attack lasts from one to three weeks, the inflammation gradually subsiding, the constitutional symptoms abating and leaving the patient weak and emaciated, with slightly stiffened and



sore joints. The stiffness and soreness soon pass away, the tissues, after a primary attack, appearing to return to their normal condition. They are, however, more susceptible to future attacks and probably there are decided anatomical changes of a microscopical nature. The chronic form will be considered later.

**TREATMENT.** In so far as it is a surgical disease the treatment consists in rest and fixation. The parts are usually the least painful if carefully wrapped in common cotton and maintained at rest by the application of either paste-board or felt splints. After the inflammation has subsided pressure and massage will hasten the restoration of function.

**Chronic Serous Synovitis.**—This is a chronic simple inflammation of the synovial membrane.

**ETIOLOGY.** Chronic inflammations of the synovial membrane may begin, as such, as the result of slight traumatisms or exposures to cold; they may be due to imperfect resolution following an acute attack or they may be the result of the irritation of loose bodies in the joints.

**PATHOLOGY.** The anatomical changes vary considerably with the time at which the examination is made. In the cases where the distension is moderate and has not lasted very long, the serous exudate containing abundant endothelial cells, a slightly thickened synovial membrane and an enlargement of the villi, with an increase in their number, are the only noticeable changes. In the later stages where the effusion is very great (articular hydrops) the changes are more marked. Even these seem due more to mechanical pressure than to inflammatory action. The extreme distension produces a stretching of the capsule and ligaments until the elasticity is destroyed; this allows of still further dilatation and an alteration in the entire conformation of the joint cavity, the synovial membrane protruding in one or more pouch-like hernias between the softened ligaments. Luxations, either partial or complete, are not uncommon in neglected cases. The constant pressure ultimately causes an absorption and denudation of the endothelium, and if the joint be maintained in a flexed position where two opposing surfaces are folded together adhesions may form and so shorten the capsule as to greatly impair the mobility of the joint. From the same causes the articular cartilages may become fibrillated and eroded, and plastic deposits upon them may result in either complete fibrous ankylosis when the effusion is absorbed or in the formation of foreign bodies.

**SYMPTOMS.** In many cases the distension of the joint, its altered outline and the subjective weakness are the only symptoms present. There is scarcely any evidence of inflammation, the heat and redness if any existed usually having passed away, the pain and tenderness being very slight and the general febrile movement entirely wanting. The presence of fluid, the chronic course, the slightly thickened capsule, and the absence of local inflammation or constitutional disturbance will clear the diagnosis.

**PROGNOSIS.** If seen before destructive changes have taken place in the ligaments and cartilages—and fortunately these are rare—the case will do well under treatment, recovering with only a slight impairment in mobility. When the degenerative changes have taken place to any extent artificially induced ankylosis is the most satisfactory termination that can be looked for.



**TREATMENT.** The treatment depends upon the condition of the joint. If the ligaments are intact the objects of attainment are the removal of destructive tension and the prevention of ankylosis. Moderately firm and equable pressure continuously maintained by means of an elastic (rubber) or semi-elastic (flannel) bandage should be first tried, the patient being allowed the free use of the joint to prevent adhesions. If this does not soon cause a diminution in the swelling so as to encourage its continuance until a cure is effected the joint should be aspirated—under the strictest asepsis—and washed out with a mild boracic acid solution or with a sterilized salt solution,  $\frac{1}{10}$  of 1 per cent. An elastic bandage should then be applied and the limb placed at rest in an elevated position for a few days, giving the blood-vessels an opportunity to regain their normal size and tone. The patient should then be allowed to go about, being careful to maintain even and constant pressure. After the effusion has disappeared the joint should be protected for from three to six months by a flannel bandage or an elastic cap. The aspiration may require repetition, and in event of a threatened or apparent ankylosis massage employed daily or every second day will be of the utmost service in its prevention or cure. In severe cases where the misshapen joint, the pouch-like projections, or the partial luxations bespeak the altered condition of the ligaments the best treatment is that which aims at ankylosis in a useful position. To attain this end may require only aspiration and irritant injections, such as iodine or carbolic acid, or it may demand an arthrectomy or even an excision of the joint. The injection should, of course, always be tried first and followed by the application of a plaster of Paris cast, when in event of failure early operation is demanded.

**Syphilitic Arthritis.**—Joint disease as a complication of syphilis occurs both in the hereditary and acquired forms. In hereditary syphilis the disease may appear as an acute or chronic serous synovitis, though more commonly the joint is involved as a sequence of specific epiphysitis. Joint disease, in acquired syphilis, may show itself in a serous synovitis during the active secondary stage, or later as gummatous deposits in the articular bone, its periosteum, the capsule, or the cartilage.

**PATHOLOGY.** The serous forms do not differ in their pathology from simple chronic synovitis save in the greater tendency to connective tissue-formations, resulting in a hyperplastic thickening of the synovial membrane and the formation of villous projections. The changes in the gummatous forms depend both upon the location and the course. If they are absorbed there is left little evidence of them. When in bone and they ulcerate the result is a typical chronic caries; in cartilage the result is the complete destruction of clearly-defined patches which become filled with newly formed connective tissue, giving the typical white cicatrices. The characteristics of the disease are the hyperplastic synovial membrane with its enlarged villi and the loss of bone or cartilage-substance owing to the formation and ulceration of gummata.

**SYMPTOMS AND DIAGNOSIS.** The symptoms do not differ from similar conditions from other causes and the diagnosis must depend largely upon the absence of other causes and a history or the presence of the unmistakable signs of constitutional syphilis. In those cases where gummata have formed in the perisynovial or periosteal tissues the characteristic nodular outline, the pain, heat and swelling are present as

in any inflammation. There is little redness unless the sub-cutaneous tissue be involved, and even then it may remain white and shining over the gummatus nodules until degeneration begins.

**TREATMENT.** These cases seldom require operative treatment before degeneration has taken place. Even when degeneration has occurred to a slight degree the well-known anti-syphilitic remedies, the mercurials and kalis, often produce the most satisfactory results. If operative measures are required no difference should be made because of the specific nature, but unusual care should be taken to prevent a secondary infection of these already devitalized tissues and the constitutional treatment should be continued perseveringly.

**Chronic Rheumatic Arthritis.**—This is a chronic inflammation involving especially the synovial membranes of adults and usually terminating in partial or complete ankylosis.

**ETIOLOGY.** In the chronic as in the acute form of this disease a microbic cause is suspected but not known. Among other causes exposure, taking cold, repeated attacks of the acute form and living in damp basements are the most frequent.

**PATHOLOGY.** Its chief characteristic, as in most chronic inflammations, is cell-formation. These connective tissue-cells form most numerous in the synovial and sub-synovial tissues, and as they become organized into fibrous tissue they contract and thus cause a marked impairment in the mobility of the joint. As the tissue increases the synovial membrane and ligaments all become blended together as a mass of fibrous tissue which in its tendency to contraction so lessens the joint cavity as to practically obliterate it in severe cases. The cartilages become fibrillated, the connective tissue gradually replacing it and extending inward from the attached margins of the synovial membrane. The two bony surfaces, with their plastic coverings, are brought into contact and become adherent, the adhesions organize and the result is complete ankylosis. These fibrous adhesions may later become the seat of osseous deposits.

**SYMPTOMS.** Stiffness, soreness, impaired mobility and occasional attacks of severe pain when taken with the history usually suffice to clear up a diagnosis. The soreness and stiffness are usually most noticeable in the morning and improve upon movement. A crackling, frictional sound, due to the deposit of fibrous tissue, can usually be detected upon motion. Acute and sub-acute exacerbations are not uncommon as the result of exposure when the pain, tenderness and swelling resemble the acute form.

**PROGRESS.** As a rule the disease is progressive after it has reached the stage of fibrous formation, so early recognition and active treatment are essential.

**TREATMENT.** In the early stages massage and active movement (Swedish) are our most reliable measures. Fixation apparatus and even the advice to keep still cannot be too strongly condemned in those cases where cure is even hoped for, because ankylosis will inevitably follow. In cases that have progressed to ankylosis and mobility is out of the question fixation with some orthopedic appliance or the plaster cast will relieve pain and aid in the induction of ankylosis, with the limb in a desirable position. Chloroform may be necessary to attain this end. Arthrotomy with antiseptic irrigation and iodoformed-gauze packing has been very satisfactory in the hands of some German surgeons and



no doubt the operative treatment even to arthrectomy and excision will be indulged in very largely before long in our own country. There is much to gain in the relief of pain, the limiting of the destructive deposits and the hastening of ankylosis, even when partial mobility cannot be secured.

**Osteo-Arthritis.**—Under this heading those diseases of joints which are nutritive rather than inflammatory in their character are included.

(a) **ARTHRITIS DEFORMANS, OR RHEUMATOID ARTHRITIS.** This is a progressive disease of advanced life often leading, as its name would indicate, to great deformity.

*Pathology.* The characteristic changes are degeneration and destruction of the cartilages which are subjected to pressure, while about the borders there is a hyperplastic deposit in the form of nodules which later become ossified. As the cartilage wears away or is absorbed the underlying bone becomes exposed, and owing to the friction becomes very hard and eburnated. It is also altered in shape, undergoing the same pressure-atrophy, even to complete absorption of the parts sustaining the pressure, while all around the margins and in the fibrous tissues of the joints are being deposited nodular osteophytes which add greatly to the alterations in the shape of the articular bones. Hyperplasia in one part and degeneration in another is quite characteristic of arthritis deformans. The capsule and ligaments also become thickened, not infrequently ossified and shortened and the synovial fringes at times so hypertrophied that the pedunculated processes of a cartilaginous consistency fall off and appear as foreign bodies.

Where the atrophic change is greater than the hypertrophic considerable shortening or even partial or complete luxations may take place.

*Symptoms.* The disease may affect one or many joints. The absence of inflammatory signs, the progressive but very chronic course, the slight pains, the marked stiffness and the occurrence of creaking sounds upon movement, and, later, the nodular deposits and the alteration in the conformation of the joint, with the movements more and more restricted, will be sufficient evidence of the nature of this disease.

*Treatment.* As before stated the disease is usually progressive and little can be done in a curative way. The progress may be stayed for a time and the patient certainly relieved by massage, daily or every second day, alternated with a mild galvanic current; besides this passive and active exercise, without exhaustion, and a close regard for nutritious food and general hygiene are all that can be done. Medicines are of use only for intercurrent ailments.

(b) **NEUROPATHIC DISEASES OF JOINTS.**—Osteo-Arthritis as a result of innervation was first described by Charcot and was regarded as a trophic disease incident to locomotor ataxia. Whether it results from this spinal degeneration, from a local neuritis, or from a traumatic section of the nerve supplying the joint, the pathological characteristics are the same and are practically identical with those already described under arthritis deformans. Briefly they are as follows: Erosion and absorption of the cartilage and the underlying bone with induration and irregular thickening of the surrounding tissues; softening of the ligaments, which rarely become the seat of bony deposits, and thickening of the capsule and synovial membrane. At first there is partial ankylosis but later the



absorption may be so great that the articular ends of bone entirely disappear, causing pathological dislocation. The ends of the shafts show no tendency to adapt themselves to each other and at times appear as simple rounded eburnated sticks.

*Symptoms.* These differ with the cause. When occurring in the course of locomotor ataxia, following its well-known prodromal signs there is a sudden and practically painless swelling of a joint without the symptoms of acute inflammation. This swelling is partly due to intra-articular effusion and in part to an extra-articular edema. The swelling may last indefinitely, is at first irregular in outline, completely obscuring the bony points, but may later, if not absorbed, assume a globular form when the ligaments soften. There is grating upon movement which in rare instances is somewhat restricted, but, as a rule, by the time absorption of the fluid takes place there is complete alteration of the joint and preternatural mobility. When due to local injury of nerves or to a local neuritis the changes are neither so rapid nor so extensive. The traumatic form is usually seen in connection with the shoulder joint and is due to contusion or section of the circumflex nerve. As a rule a fall or other injury causes an acute serous synovitis, with its usual attending symptoms. As the acuteness of the symptoms passes away the patient notices that there is no return of function and generally consults the surgeon after ankylosis is complete.

There is little pain and in addition to ankylosis there is gradual atrophy of the muscles supplied by the diseased or injured nerve, which soon shows the reaction of degeneration to electric stimulation. These cases rarely go on to complete disorganization and absorption of the bone, for the reason that the joints usually have two or more nerves to guard their nutrition and so the destruction ceases with partial absorption of the cartilages and adhesions of the opposing surfaces.

*Treatment.* In Charcot's disease proper there is little to be done save by massage and rest to prevent extensive absorption and deformity. In the traumatic form, even after the muscles have lost their contractility to Faradic stimulation, the daily use of electricity—both the continuous and interrupted currents—with massage as an adjuvant, has, in the author's experience at least, prevented the extreme atrophy of muscles and that degree of degeneration of articular cartilages making restoration impossible. Nature meanwhile brings about the regeneration of the injured nerve.

**Tubercular Inflammation of Joints.**—Tubercular arthritis, the tumor albus of all authors, is a chronic infective inflammation of joints.

**ETIOLOGY.** Whether primary or secondary, tubercular inflammation of joints, the same as tuberculous inflammations elsewhere, is invariably the result of the localization and development of the bacillus of tuberculosis. As a localizing factor traumatism is unquestionably of the greatest importance. If the anatomical peculiarity of the blood-vessels in articular ends of bone during their active development and the almost daily shocks and falls to which children are subject be borne in mind the apparent predisposition of these structures to tubercular disease is easily explained.

**PATHOLOGY.** The original focus of inflammation usually occurs in

one of the vascular tissues, i. e., the bone, or the synovial membrane. It seldom if ever involves primarily either the ligaments or the encrusting cartilage. The pathological conditions depend somewhat upon the location, and in young people this is most frequently a primary osseous focus. The bacilli, having gained entrance into the circulation either through the mucous membranes or from some primary tuberculous lesion, are readily deposited in the blood-vessels of the actively growing epiphyses of long bones, particularly if their walls have been slightly damaged by traumatism. They begin to multiply and by their action convert the cells into lymphoid and giant cells which for the most part become concentrically arranged, forming the original tubercle as described in Inflammation. As the individual tubercles increase in number a circumscribed focus of tubercular granulation is formed.

These granulations penetrate the cancellous spaces in all directions, causing first an absorption of the bony walls, thus enlarging the normal channels and giving the bone a porous or spongy appearance (osteoporosis), and, later, resulting in the complete softening and absorption of the bone and its replacement by granulation tissue (rarefying osteitis). When the development of these granulations is very rapid the bone is deprived of its nourishment before liquefaction and absorption can take place, and large or small portions of dead bone are thus separated from their normal connections by layers of granulation (tubercular necrosis). At other times, when a terminal branch of an arteriole is occluded by the developing granulations, a triangular piece of territory is suddenly deprived of its nourishment and dies (tubercular infarcts), thus giving rise to the wedge-shaped sequestrum which is regarded as typical of bone tuberculosis. The base of the wedge is directed always to the joint surface, and is large or small accordingly as the occluding thrombus is far from or near to the encrusting cartilage. The secondary changes in the tubercular lesion are the same as in soft structures. The round-celled infiltration excited by the presence of this foreign body may develop so strong a wall as to limit definitely the spread of the inflammation; the tubercular germs then soon exhaust their supply of nourishment and become so inactive that nature is able to destroy them. The granulations undergo fatty degeneration and absorption and the new cells develop to fill up the cavity, becoming transformed into healthy fibrous tissue (fibroid induration). When the progress is slow the granulation focus becomes larger and larger until the central position is so far from nutritive vessels that it undergoes fatty degeneration. This degeneration spreads, the fluid portion is drained away, leaving a cheesy-looking mass of cells surrounded by the tubercular granulations (caseation). When the progress is still more rapid the central degeneration is the same, only, being so rapid, the liquid portions are not absorbed and the central portion of the tubercular area consists of broken down cells, oil globules, shreds of fibrin and serum—possibly also the sequestra above alluded to—surrounded by the actively growing granulations and, still externally, nature's round-celled infiltrate (tubercular abscess). Any of these conditions may remain stationary, but progress is the rule and the advance may be toward the surface of the bone. It is usually in the direction of the circulation, i. e., toward the articular surface, and the granulations or pus, as the case may be, finally enter the joint cavity. The changes which

occur in the synovial membrane are the same, whether it is involved primarily or secondarily. The synovial membrane, becoming thus infected in one or many places, undergoes a similar transformation to that described. Granulation tissue in time grows into all parts of the joint, the synovial membrane becoming practically converted into a fungous mass of granulations (fungus arthritis). This is the most common form, and in the early stages the joint cavity becomes distended with a serous or sero-fibrinous exudate (tubercular hydrops). Later, as caseation or fatty degeneration of the granulations takes place, the liquefied fibrin and cheesy matter, or oil globules, drop into the cavity and form with the other exudate the typical tuberculous pus. Whenever this tubercular granulation spreads it destroys the normal tissues, and, in turn, the cartilages are either completely absorbed or separated from the underlying bone and drop into the cavity. The capsule and ligaments become infiltrated and so softened that they are unable to perform their functions, and thus the normal outline of the joint is lost and the globular form so characteristic of this disease in the late stages is assumed. If the bones have not originally been diseased they become so and the sequence is the same as in primary involvement. In other cases (termed miliary form) there is no great formation of granulation tissue, but the synovial membrane becomes infiltrated with inflammatory deposits, in the form of grayish-white nodules, which give rise to an extensive exudate of the serum into the joint. This form seldom goes on to complete disintegration of the joint-structures but is finally overcome by nature, the nodules and cells being replaced by the formations of fibrous tissue (fibroid induration), and ankylosis results.

**SYMPTOMS.** Tubercular arthritis may occur at any age but is most common during the period of active development. In young people the primary osseous form is most common and early recognition, before joint involvement occurs, is extremely important. Tuberculosis of the articular bones may be recognized by the following symptoms:

*Pain.* When the pathological conditions are borne in mind and when it is remembered that all inflammatory pain is produced by tension great suffering would not be expected in this disease. Indeed the focus may have attained considerable size before the patient complains at all. There is usually some dull pain, perhaps intermittent in character, and always worse at night. Pain is aggravated by movement and by jars transmitted along the limb.

*Tenderness.* Diligent search will seldom fail in discovering a tenderness upon pressure in tubercular osteomyelitis of any extent. It is the most reliable single symptom. It is most marked, of course, as the disease approaches the surface, the point of the greatest sensitiveness corresponding to the center of the focus.

*Swelling.* Until periosteal, or at least sub-periosteal, involvement occurs the swelling is not generally well marked, and still, in many cases distinctly localized, the swelling is apparent early. The swelling is usually most obvious at the point of greatest tenderness in the early stages; after periosteal abscesses form this is not so frequent.

*Effusion.* There is often a serous exudate into the nearest joint from purely circulatory disturbances prior to synovial involvement which, if occurring early, is simply confirmat<sup>ve</sup>. When a growing child com-



plaints of pain in or about a joint and shows an indisposition for active exercise on account of increasing the pain; when careful examination elicits a circumscribed area of tenderness; when, day after day, there is a slight evening elevation of temperature, though it be only a half of one degree, a local tubercular lesion may be strongly suspected. If, with these symptoms, there is swelling, effusion into the joint and local heat the presumption becomes positive. In the later stages and in primary synovial involvement the diagnosis is much more easy. The joint becomes fixed by the voluntary muscular contraction, the swelling, at first outlined by the synovial cavity, becomes globular in form; the sense of fluctuation becomes less distinct and is replaced by a soft, doughy sensation. The rigidity of the joint soon results in atrophy of the muscles both above and below and, together with the distended white, shining skin traversed by blue veins, gives the typical "ferule-like" appearance, in itself diagnostic of "white swelling."

**TREATMENT.** The treatment of tubercular arthritis depends much upon the stage at which the patient is seen. In the early stages, whether primarily osseous or synovial, absolute rest for the joint, by encasing it in a plaster cast, by fixation with extension splints, or by rest in bed with extension continuously employed, is the local measure. Too much emphasis cannot be laid upon the necessity of constitutional treatment in local tuberculosis. A large percentage of cases seen in the early stages may recover without operative interference by giving the patient the best hygienic surroundings, an abundance of the most nourishing food, including cod-liver oil in some form, moderate exercise in the open air and careful attention to the details of bodily cleanliness and warmth. If rest and constitutional treatment fail in arresting the progress of a disease which is primarily synovial, an injection of a sterilized ten per cent. emulsion of iodoform in glycerine may be tried. This should be done under the strictest antiseptic precautions, the quantity varying, according to the joint involved, from two to eight drachms. The patient is then allowed to use the limb so as to bring the iodoform into contact with all of the diseased structures. The injection may be repeated in a week or two weeks if necessary. The results have been fairly satisfactory, the iodoform appearing either to have a direct anti-tubercular action, or else exciting a cellular activity which is capable of overcoming the progress of the inflammation. Koch's tuberculin has not been satisfactory in the treatment of joint tuberculosis. The treatment of this class of cases by the production of a mechanical stasis as recommended by Bier at least deserves investigation. This plan was adopted because of the infrequency with which congested lungs became the seat of tubercular deposits. Passive hyperemia is secured by the application of an elastic constrictor applied on the proximal side of the diseased joint. If the results of others prove equal to those of the originator operative cases will be greatly lessened.

The operative treatment of tuberculosis of joints includes many operations and can be better discussed in the chapter devoted to operations. When in spite of the earnest trial of the methods above detailed the disease progresses operative measures are the only means of arresting the destruction or of saving the life of the patient. The nature and the extent of the disease must determine the surgeon in the selection of

operation. In all cases where a primary osseous focus is recognized prior to joint involvement, and rest and constitutional treatment fail in arresting development, operative measures are necessary.

Removal should be by exposure with a chisel without entering the joint cavity. When the cavity is involved arthrectomy, atypical or typical excision or amputation must be resorted to, depending upon the individual case. The differentiation will be given later.

*Medication.* Besides the general constitutional treatment necessary in tuberculous states there are certain remedies which have special affinity for the joints, particularly in young subjects, that should not be overlooked in the treatment of tuberculous conditions of these structures. *Calcareo carbonica* and *calcareo phosphorica*, more particularly the latter, should not be forgotten. The *calcareo cachexia*, the lack of strength and robustness that should belong to children of the years in which tuberculous affections of the joints occur, calls loudly for *calcareo*. Nightly sweatings, coolness of skin, tenderness of joints, lack of appetite and vigor, recurring headaches, and mental and bodily fatigue complete the indications for *calcareo carbonica*.

*Calcareo phosphorica* is especially to be thought of in tuberculosis of the bones and joints. Its symptomatology covers the combined picture of *calcareo* and *phosphorus*.

*Rhus tox* will be found beneficial in the nightly pains of tuberculous joints, especially when the condition simulates rheumatism. Pains worse as night approaches and in damp weather.

*Symphytum* will often modify or altogether relieve the bone pains of osteo-myelitis, from whatever cause. It should not be overlooked in the pains of tuberculosis of bones and joints.

*Silicia* is of paramount importance in tuberculosis and other disease of bone. Caries sicca; ulceration of bone; fistulous openings into the medullary canal; osteitis from whatever cause. Hectic symptoms with tuberculous affections of bones and joints. *Silicia* will also be found an invaluable remedy in infective synovitis, and in suppurations from joints and bone cavities.

*Calcareo fluorica* is a strong rival of *silicia* in like conditions. It is, however, more applicable to bone ulceration and nodulation due to syphilis, and to bone disease following the abuse of mercury.

*Calcareo sulphurica* may also be consulted to advantage, as, likewise, *sulphur*, *nitric acid*, *sepia*, *ferrum phosphoricum* and other homeopathic remedies.

The iodide of arsenicum will best meet the constitutional state in most cases not calling for *calcareo*.

#### CHAPTER IV.

### TUBERCULAR DISEASE OF SPECIAL JOINTS.

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**Sterno-Clavicular Tuberculosis.**—This joint is particularly interesting from the fact that it has an intra-articular fibro-cartilage which divides it into two compartments, both of which are lined with synovial membrane. Tubercular disease may be, as elsewhere, either primarily of that membrane or secondary to bone disease. It is more frequent in adults than in children. The symptoms are pain, tenderness, local heat and swelling. The pain is apt to be constant, owing to the difficulty in maintaining immobility of the joint.

**TREATMENT.** Fixation being practically impossible injection of iodoform emulsion should be first tried, provided the synovial membrane be primarily affected. The bone being superficial, focal points of disease may be readily detected and removed by incision and scraping before joint involvement occurs. Later, when sinuses have formed, atypical or typical excision of the joint, or partial or complete resection of the clavicle, may be demanded. Operation should not be delayed when injections have failed or when sinuses have formed.

**Tuberculosis of the Shoulder.**—The shoulder is less frequently the seat of tubercular inflammation than any of the large joints. It is more common in young adults than in children, and the original focus is much more frequent in the greater tuberosity or the head of the humerus than in the synovial membrane. There are two distinct forms of tuberculosis that attack the shoulder joint—the granulation focus, or fungus arthritis, and the caries sicca of Volkmann. Fungus arthritis of the shoulder does not differ from the process already described. The infection, if originating in the bone, soon penetrates the encrusting cartilage and involves the synovial membrane, which becomes covered with tuberculous nodules and ultimately replaced by the excessive granulations typical of this form of the disease. The early symptoms are pain, localized tenderness, partial disability of the joint and moderate elevation of temperature in the evening. As the disease extends the synovial sac becomes distended, either with fluid or granulations. The joint assumes a globular shape, is very much enlarged, hotter than the surrounding parts, the skin being smooth, peculiarly white and traversed by distended and very blue veins. Abscesses when formed either rupture into the axilla or follow the inter-muscular spaces.

**Caries Sicca.**—This is a peculiar form of the tubercular disease affecting children and young adults, characterized by the formation of scanty, feebly-vascularized granulations. These begin usually in the synovial membrane, penetrate the cartilage and gradually cause the absorption of a large portion of the head of the bone without any tendency to pus-formation. There are no signs of inflammation present and the pain, which is of a rheumatic nature, the rigidity and, later, the atrophy of the muscles and the gradual wasting away of the head of the humerus being the diagnostic



symptoms. This form of the disease is rarely seen in other than the shoulder joints, its course is chronic, extending from one to three years and being characterized by a tendency toward resolution with ankylosis of the involved joints.

**TREATMENT.** Caries sicca requires little else than rest and careful attention to the general nourishment and hygiene. The duration of the disease and its extent may be somewhat limited by intra-articular and parenchymatous injections of iodoform-glycerine. Operative measures are seldom, if ever, called for.

In the fungous form with a primary synovial focus iodoform injections have been very satisfactory in their results, and are also worthy of a trial in the early stages of synovial involvement secondary to an osseous focus.

In a primary osseous disease, definitely located before extension of the synovial membrane has taken place, if rest and constitutional measures have failed in arresting its progress removal should be attempted without entering the joint cavity. This may be done either by means of chisels and gouges, or, after exposing the focus, by the actual cautery if it is found in direct continuity with the joint. Cases which have progressed farther will require arthrectomy, excision or even amputation.

**Tuberculosis of the Elbow.**—Tubercular inflammation of the elbow joint begins about three times as often in the bone as in the synovial membrane. Of the bones entering into the joint formation the olecranon process of the ulna is most frequently the site of localization, the humerus the next and the radius only rarely.

When beginning in one or more of the bones the usual symptoms of osseous inflammation are manifested and precede, for some time, the joint involvement. Among the earliest signs of joint disease is restricted movement. The patient usually holds the arm flexed and slightly pronated, and cannot fully extend it. Swelling commonly appears, first at the sides of the olecranon process, particularly between it and the head of the radius. As the swelling increases the joint becomes more fixed and flexed, and movements of pronation and supination are abandoned, all rotary movements of the arm taking place at the shoulder joint. As the capsule and ligaments become softened the swelling assumes a typical spindle shape, the para-articular tissues become involved and the muscles atrophy. Secondary changes, such as caseation and abscess-formation, take place and quickly involve the skin, rupturing externally, leaving sinuses through which pyogenic infection takes place, rapidly extending through the already diseased tissue until the whole joint structure becomes destroyed.

**TREATMENT.** Early recognition and fixation in the flexed position are of the utmost importance in the treatment of elbow-joint disease. Immobilization should always be complete and in the bent position, in case ankylosis ensues. The plaster of Paris cast serves a much more thorough purpose than any form of splint, and should be applied so as to include the wrist. Treated thus in the early stages, partial mobility may usually be promised, and even complete restoration of mobility is not infrequent after months of rest. Primary osseous foci should be treated as elsewhere, by removal. In the later stages when the joint is the seat

of fungous arthritis, and particularly when the disease is primarily synovial, iodoform injections will hasten resolution in many cases, the result being a fibrinous ankylosis. The nature of the joint renders arthrectomy very difficult, and as ankylosis would be a foregone conclusion excision offers a better prospect of a useful joint. Amputation may be required in the event of serious involvement of the soft structures, and particularly in those cases where acute suppurative inflammation has been added to the tubercular disease.

**Tuberculosis of the Wrist Joint.**—Whether the disease attacks primarily the synovial membrane or the carpal bones (and they seem to be about equally frequent) the whole joint soon becomes involved. Primary foci in the bones of the forearm are less seldom seen, but it is well also to remember that the wrist may become involved by direct extension from a teno-synovitis of a tubercular nature. A sense of weakness in the wrist and gradual atrophy of the muscles of the forearm are the usual forerunners of the well-defined symptoms, and when the bones are involved local points of tenderness and increased temperature may suggest tuberculosis even before swelling appears. Swelling is usually present in a marked degree before the surgeon is consulted. It appears first between the tendons of the dorsum, obliterating the interspaces, but gradually increases until the whole circumference of the joint is increased. As the destruction continues the swelling encroaches upon the hand and forearm, the tissues appearing uniformly swollen, the hand flexed and slightly abducted. The swelling, the limitation of movement, the atrophy of the muscles and the increased temperature without signs of acute inflammation make a typical illustration of tubercular disease of this joint.

**TREATMENT.** Fixation with plaster of Paris bandage, combined with a dorsal splint when there is a tendency to flexion, shows gratifying results in the early stages. If the disease is primarily synovial or if the bones are not extensively involved iodoform injections will give a better functional result than operation. When these methods have failed, or the disease appears too extensive for their trial, excision of the capsule and involved carpal bones will usually result in a partially movable joint.

Tubercular disease of the carpo-metacarpal and of the metacarpophalangeal joints is too rare to demand separate description. The former may be involved in the late stages of the diseases of the wrist-joint and demand complete wrist excision, and the latter as a complication of tubercular osteo-myelitis of the metacarpal bones or of the phalanges (tubercular dactylitis). These will both be considered in the surgery of the osseous system.

**Sacro-Iliac Disease.**—Tuberculosis of this joint is not of frequent occurrence—less so, indeed, than pyemic involvement. The joint is peculiar in that it has no synovial membrane in the majority of cases, the articular cartilages lying in direct contact but not fused. The joint receives its nerve supply from the lumbo-sacral cord and branches of the sacral nerves. It is also of diagnostic interest to remember that the obturator nerve and the lumbo-sacral cord pass directly over the front of this joint. As the anterior ligaments are more feeble than the posterior early involvement of these nerves is not uncommon, and by the reflected pains may easily mislead an incautious surgeon. There is usually a history of trauma, either direct or indirect, through a strain.



**SYMPTOMS.** The onset is very insidious, the patient first noticing a weakness of the leg of the affected side and a desire to favor that side as much as possible. Pain is not often so localized as to call attention to the joint. From the nerve supply and the relationship it is easily understood how the pain may be in the hip, the knee or the buttocks. The pain's not being relieved by sitting is quite characteristic. It is aggravated by any movement and may be located by tenderness over the joint, or by lateral compression of the pelvis. Swelling is not generally well defined, for the reason that when suppuration occurs it tends to press forward (this being the line of least resistance), ruptures the anterior ligaments and presents as an iliac abscess between the femoral vessels and the anterior-superior spine. More rarely the pus finds its way into the sheath of the psoas muscle or follows the course of the sciatic nerve, to appear on the buttocks. The locality of the tenderness, the pain upon compressing the pelvis, and the freedom with which the hip joint may be moved when the pelvis is held rigid will serve to differentiate from hip disease when the pains are all referred.

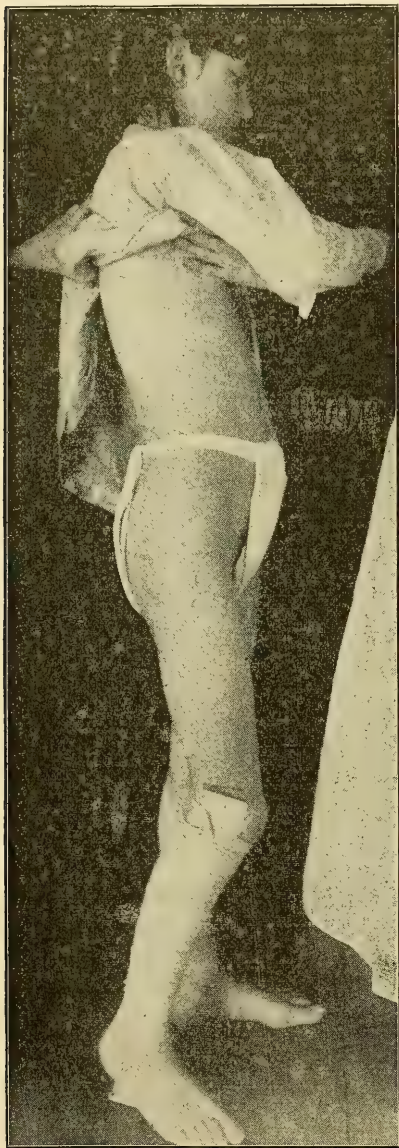
**TREATMENT.** Absolute rest, obtained by means of a plaster of Paris cast about the pelvis and thighs, offers the best results in the early stages. Where suppuration has taken place and the ligaments are yielding the joint should be aspirated, iodoform-emulsion injected and rest secured as above directed. These failing, or where sinuses form, a free longitudinal incision into the joint and the chiseling away of enough bone to allow of the complete removal of the diseased area and insure perfect drainage comprise the only treatment to adopt. Iliac abscesses from this source should be incised, sterilized and drained; but attention, as above directed, to the original focus of the disease is imperative if we would obtain the best results.

**Tuberculosis of the Hip Joint.**—In the light of recent research most cases of hip disease or morbus coxarius are regarded as tubercular in character. This disease is much more common in children than in adults and by far the greater number of cases have their primary focus in the bone. In order of frequency the bones involved are the acetabulum, the neck just external to the epiphyseal line, the head and the great trochanter. In the majority of the cases where the primary disease is in the femur the focus is sufficiently large to cause some sequestration. Primary synovial disease is no doubt more frequent than was formerly thought, but the early involvement of the joint-cavity when the disease begins either in the head or neck of the femur, or in the acetabulum, renders it very difficult to estimate percentages. The pathological changes do not differ from those already described and the symptoms vary only because of the depth of the joint and the peculiarity of its nerve supply.

**SYMPTOMS.** The symptom generally first noticed is a limping gait, owing to a spasmodic muscular contraction that holds the hip joint fixed. There may be pains to account for this contraction, or the patient may not complain of suffering except in certain movements of the joint. The pain, mild or severe, may be felt in the hip, or, as is more commonly the case, may be referred to the knee joint. This knee pain has been usually attributed to the distribution of the obturator nerve and the branches of the sciatic nerve, and looked upon as a reflex manifestation. As there is no reason why the pain should not be referred to the peripheral distribu-



tion of these as of other involved nerves, and as the obturator does not stop at the knee but extends in most instances to the middle of the leg the pain is being regarded more and more as a mechanical extension along the femur from involvement of the medulla. The pain may be accompanied by tenderness to direct pressure over the capsule or perhaps excited only by certain movements or by jarring the limb. Starting pains, or, as they are often termed, "night cries," are common in later stages;



**Fig. 53. Characteristic Position in Morbus Coxarius.—Wilcox Hospital Case.**

swelling is, as a rule, not well marked, owing to the depth and natural conformation of the joint. There is generally a slight fullness over the front of the joint and a gradual lessening in the distinctness of the gluteal fold, which may be attributed in part to swelling, in part to the muscular atrophy and in part to the flexion. The characteristic signs are the purely mechanical ones, the limb assuming that position in which the joint can contain the most fluid with the least tension and pain. The early changes are flexion, abduction and eversion, as in this position both heads of the ilio-femoral ligament, as well as the general structures, are relaxed. (Fig. 53.) With these there is apparent lengthening of the limb, owing to the tilting downward of the pelvis which is necessary to make the abducted leg parallel to the normal one, and lordosis, the hip being fixed by rigid muscles in the flexed position, this immobility demanding compensation in the mobility of the lumbar vertebræ. Later the joint becomes further flexed, adducted and inverted. This change is attributed by different authors to a yielding of the ligaments and capsule, to an erosion of the lip of the acetabulum and to a reflex spasm of the adductors opposing an exhausted group of abductors and external rotators. The mechanical reasons given in the first two appeal the more strongly. With this position there is apparent shortening of the leg from tilting upward of the pelvis, incident to making the adducted leg parallel to the normal. Still later there is an aggravation of flexion, inversion and adduction, with actual shortening of the leg, owing to absorption of the head and neck of the

femur and consequent partial or complete dislocation upon the dorsum illi.

The tilting of the pelvis is easily noted by drawing two lines, one from the ensiform cartilage through the umbilicus to the symphysis pubis, and the other connecting the two anterior-superior spines. In health these should cross at right angles, and the deviation from a right angle will show the degree of the obliquity of the pelvis. The lordosis is best observed by laying the patient on a straight table and bringing the limbs down parallel to each other. The marked anterior lumbar curvature (lordosis) thus noted disappears entirely upon allowing the limb to assume its flexed position. The constitutional symptoms are those of tuberculosis elsewhere—fever and emaciation.

**TREATMENT.** The most satisfactory treatment in children old enough to understand the importance of quiet is fixation by means of a long external splint combined with the weight and pulley extension. The bed must be firm and the splint must have a cross-bar to prevent rotation; in very restless children it is safer to have splints on both sides of the body connected at the foot by a cross-piece. It would be difficult to imagine anything more senseless than extension without fixation, and yet it is no uncommon thing to see a little child in bed with hip disease with a pulley attachment to his leg but perfect freedom to sit up whenever he desires. If fixation and extension cannot be combined, as in very young children, fixation is of infinitely greater importance. It should be secured by a plaster cast extending from the toes to the waist, great care being observed to protect the groin and perineum. The patient should not be allowed to use the joint for one or even two or three months after all symptoms have subsided, though he may be allowed to go about on crutches, using the well leg made long by the addition of a cork sole, thus allowing the weight of the diseased leg to act as its own extension. Many advise the application of “walking splints,” such as Sayres’ and Thomas’ long splints. They cannot be relied upon as curative agents and in the author’s judgment should be recommended only after fixation and extension have practically cured the case. Outdoor exercise is advisable, otherwise recurrence is not unlikely. Iodoform injections have not been as successful in the hip as in other joints, and still when the disease is primarily synovial or acetabular the trial should be made before resorting to more serious measures. If the disease be located in the neck of the femur or great trochanter an extra-articular operation for its removal may be attempted.

Arthrectomy of the hip is seldom practiced. It is an extremely difficult operation and demands more time and larger incision than excision, with a questionable improvement in results. Typical excision where it must, and atypical where it may be practiced are the most satisfactory operations. Where the disease is too extensive to promise satisfactory results from these, amputation may be resorted to.

**Tuberculosis of the Knee Joint.**—Tubercular inflammations of the knee are among the most interesting of surgical conditions, not only because it is the joint most frequently involved but also for the reason that it offers for study every clinical form of tuberculosis of joints and is the most typical joint for every method of treatment now in vogue. The primary focus of disease, according to most observers, is, in childhood and old age, about twice as often osseous as synovial; in young



adult life they occur with about equal frequency. The femur is more often affected than the tibia; in both the focus is limited generally to the epiphyses. The pathological conditions need not be repeated.

**SYMPTOMS.** In the osseous form pain is usually the first symptom. It may be and usually is intermittent in character, very severe and always worse at night. A focal point of tenderness may generally be elicited upon careful examination, most commonly in one condyle of the femur and next oftenest in the head of the tibia. The evening temperature is always elevated, though not necessarily more than one-half of one degree. After a time there is usually some swelling of the bone, at first defined, later becoming more general. The joint will be found hotter than the surrounding structures. Depending upon the depth and location of the focus there is an early or late synovial effusion of a serous nature which may depend entirely upon circulatory changes and not upon secondary involvement. Impaired movement and muscular wasting are soon added—indeed the former may be a symptom from the very first onset.

In primary synovial tuberculosis the knee may have become very much swollen before the child even limps or complains of any pain. There is little if any tenderness, and the general temperature does not increase so uniformly in the early stages. When the synovial membrane is involved, the condition is typically illustrative. With the pain, heat, tenderness, muscular atrophy and impaired movement there is the swelling, at first outlined by the synovial membrane and gradually becoming more and more globular as the ligaments soften and yield to intra-articular pressure. The knee is flexed, the skin tense and very white in contrast to the blue and dilated veins which pass over it. As the ligaments become softer and more yielding the tibia is frequently displaced backward and, from the weight of the leg, usually rotated outward. Peri-articular abscesses form, which, rupturing, leave sinuses lined with typical tubercular granulation tissue. "Starting pains" are nearly always present in the later stages. The general symptoms, of course, increase in severity until the patient, becoming emaciated and anemic, finally dies either from exhaustion, general tuberculosis or septicemia as the result of secondary infection from pus microbes through the sinuses.

**TREATMENT.** In the early stages, whether the disease is primarily osseous or synovial, continued rest in the extended position should be first tried. This is best accomplished by means of a plaster cast, the patient being allowed to go about on crutches and having the well leg lengthened by a cork sole added to the shoe. In this way the weight of the limb is an extension and helps to keep the joint surfaces apart. In the synovial form, where there is a large effusion (articular hydrops), the fluid should be aspirated and iodoform and glycerine injected, the joint being used so as to bring the iodoform into contact with the whole of the diseased tissue. In a primary osseous focus, if rest has failed, the disease should be removed by operation, without entering the joint cavity. If these measures fail, or if the joint has degenerated to such a degree as to render this procedure useless, the choice should be, in the order named, arthrectomy, excision or amputation.

**Tubercular Disease of the Ankle Joint.**—Primary synovial disease is more common than a primary osseous focus. In the osseous form the astragalus is more frequently involved than the tibia or fibula.



The earliest symptom as a rule is impaired function and, following the interference in movement, there are heat, pain and swelling, which are very variable. The swelling appears first under the flexor tendons and later may be easily made out on both sides of the tendo Achillis. In the osseous form there will have been pain, tenderness and probably some enlargement of the involved bone prior to synovial effusion. As the disease progresses the swelling assumes the characteristic globular outline, showing the softening and yielding of the ligaments, and the foot is held in extreme extension. It must not be forgotten that tubercular disease may affect primarily any of the tarsal joints proper, although they are generally involved secondarily. The more distinct localization will suffice for diagnostic purposes and the essentials of treatment are the same.

**TREATMENT.** The earlier this is enforced the better the functional result. Fixation of the joint with the foot at right angles to the body, by means of a plaster of Paris cast, either alone or in combination with iodoform injections, should be first tried. The importance of maintaining the position at right angles cannot be over-estimated in cases where ankylosis results. Where these measures fail arthrectomy or atypical resection, or even amputation, is to be preferred to excision if this latter operation demands the removal of both os calcis and astragalus, and especially so if total tarsal resection is necessary to remove the disease.

## CHAPTER V.

# RESULTS AND COMPLICATIONS OF JOINT DISEASES.

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**Ankylosis.**—Ankylosis means partial or complete pathological fixation of a joint. Ankylosis may be fibrous, bony, or intra-or extra-articular.

**CAUSES.** Ankylosis is, in most cases, the result of inflammation, in a few is due to impaired nutrition and in still fewer to cicatricial contractions during the healing of the soft parts and to fractures into joints.

Fibrous ankylosis may be due to adherent fibrous deposits in an inflamed synovial membrane; to erosion of cartilage and fibrous adhesion of bony surfaces, or to an inflammatory softening and subsequent fibrous infiltration of the capsule, the ligaments, and the tendons about a joint.

Bony ankylosis may result from osseous deposits in fibrous tissue, but is more common as the result of fractures into joints or direct union of the bones entering into the joint formations after the ulceration or absorption of the encrusting cartilage.

**SYMPTOMS.** Rigidity of a joint that is not a manifestation of hysteria or is not caused by muscular spasm on account of pain is the obvious sign of ankylosis. The differentiation between the fibrous and bony forms is not always easy without the employment of an anesthetic. In the fibrous form there is some movement though it may be slight, usually a little pain and muscular contractility accompanying motion. In the bony form there is no movement, no pain, and absolutely flaccid muscles.

**TREATMENT.** The treatment will, of course, vary with the nature of the disease causing the rigidity. In fibrous ankylosis, as the result of a simple inflammation which has subsided, the patient may be anesthetized and the adhesions forcibly broken up. Passive movements and massage of the joint being daily and energetically used until the patient can make active movements serve a better purpose. These measures, preceded by a hot bath or steaming, may be sufficient without the forcible rupture of the adhesions in moderately rigid joints.

When fibrous ankylosis has resulted from an infective inflammation, as a tuberculous or pyemic synovitis or arthritis, the possibility of exciting favorable conditions for the development of latent germs should always be borne in mind. It should never be done while any signs of inflammation still exist and seldom earlier than three or even six months after all evidence of inflammation has subsided. The forcible rupture of fibrous bands is not entirely free from other dangers, especially in those cases where there are marked extra-articular deposits about the tendons, nerves and ligaments. To avoid the danger of rupturing blood-vessels and nerves forcible movement should always be first exercised in a direction which relaxes these structures—i. e., flexion. Tenotomy may be

considered and some surgeons advise the dissecting out of adherent tendons. Neither method will be frequently called for.

The muscles moving the joint, if markedly atrophied, must be treated by massage and electricity before the operation, so as to improve their nutrition and render them capable of doing the work expected of them. Nor should such measures be discontinued for a considerable time afterward if the best obtainable results are expected.

In bony ankylosis if the limb be in a good position no treatment is called for, as this result is the best the conditions allow of. If, for instance, the elbow is flexed at right angles, or a trifle less, it should not be interfered with; if extended, excision is called for. If the knee be fixed in a flexed position and the ankylosis be bony it demands a wedge-shaped excision and fixation in the extended position or an osteotomy of the lower part of the femoral shaft. Osteotomy below the trochanter is the most satisfactory operation for ankylosis of the hip in flexion.

**Loose Bodies in Joints.**—Loose bodies may be formed in many ways, some of which have already been mentioned in the description of joint diseases. The principal sources may be enumerated thus: Hypertrophic or hyperplastic outgrowths of the synovial fringes and villi, which subsequently become cartilaginous and detached; loosened portions of the articular cartilages, either from injury or disease; organization of blood clots by fibrinous deposits, and the separation of outgrowths of cartilage or bone (osteophytes).

**SYMPTOMS.** The characteristic symptom is a sudden and sickening pain when the body is caught between the articular bones during movement. The pain is due to a stretching of the ligaments and may be so great as to cause the patient to fall if the knee joint be the one involved. These attacks are usually followed by serous synovitis of sub-acute form. Examination of the joint after the swelling subsides will, in many cases, reveal the presence of a movable body somewhere in the synovial sac. It may disappear and remain hidden for a considerable time in some of the synovial pouches and give rise to little inconvenience, but usually sooner or later the attack is repeated. In other instances the inflammation excited may result in fibrous deposits upon the foreign body and its firm attachment to some part of the synovial membrane where it gives rise to no symptoms.

**TREATMENT.** During an acute attack the treatment is that recommended for acute synovitis; rest, elevation and hot applications, followed by compression to hasten absorption. After the inflammation has subsided the question of removal of the foreign body must be considered. If it has become attached and promises to interfere only slightly with the usefulness of the joint the patient should wear a flannel bandage or an elastic cap for a few weeks until adhesions are firm. The prolonged use of an elastic cap must be strongly condemned as causing needless atrophy and weakness of the limb.

Where the joint is not the seat of an incurable disease (osteo-arthritis), where the presence of the body interferes markedly with the usefulness of the limb, and especially if it can be located, the joint must be opened and the body removed.

This operation depends for its success upon the strictest adherence to the rules of surgical cleanliness. The body, if possible, should be trans-



fixed with a sterilized needle to render it stationary and then an incision sufficiently large to admit of extraction without undue force made directly upon it. Neither irrigation nor drainage is necessary, the wound being carefully sutured for its entire length.

## CHAPTER VI.

### DIFFERENTIAL DIAGNOSIS OF JOINT DISEASES.

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A joint consists of a synovial membrane, ligaments, encrusting cartilage and articular bone. The characteristics of primary diseases of these structures should, therefore, be kept in mind.

(a) The chief characteristic of an inflammation of synovial membrane is swelling. The swelling corresponds in outline to the synovial cavity and, in acute cases, movement in any direction is attended by pain. When effusions at first outlined by the synovial membrane become globular in form softening and yielding of the ligaments are indicated.

(b) The chief characteristic of early inflammation of ligaments is position. The position assumed is the one in which the involved ligaments are relaxed, and any movement tending to put them on a stretch is resisted on account of the pain. The further involvement of ligaments may be recognized by an abnormal relationship of the articular bones, the loss of outline of the synovial membrane, or preternatural mobility of the joint.

(c) The characteristics of inflammation of cartilage are loss of smoothness in joint movements and, later, the "starting pains" when the muscles are off guard. As cartilage is not supplied with sensory nerves these pains indicate ulceration of the cartilage and exposure of the underlying bone.

(d) The chief characteristics of inflammation of the articular ends of bones are deep gnawing pains and, especially, tenderness on pressure. These symptoms are present before any well-defined swelling takes place, the area of most acute sensitiveness corresponding usually to the central focus of inflammation.

1. When, immediately after a severe wrench, strain or contusion of a joint, the synovial cavity is found distended and fluctuation is easily elicited, or when the parts are neither red, hot nor especially sensitive to touch, the condition is one of hemarthrosis or hemorrhage into a joint.

2. After such a history or when following the chilling of the joint the synovial cavity is found distended with a fluid which has accumulated within a few hours, when the parts are hot, painful and tender, when the pain is greatly aggravated by even the slightest movement, the condition is one of acute serous synovitis.

3. With a history of acute serous synovitis of several days' duration, when there is no tendency to amelioration, but, on the other hand, the condition grows progressively worse, when the pain becomes more acute, the joint more tender, the superficial tissues very red and edematous, and especially if chills and high febrile symptoms supervene, acute suppurative synovitis exists.

4. When one or more joints become swollen during one of the acute infective fevers or in the course of an attack of gonorrhea or of suppuration elsewhere, when attended by local pain, heat and tenderness and the

general symptoms become greatly aggravated, the condition is one of pyemic synovitis. It is well to remember that this is not necessarily suppurative though it may go on to rapid and complete destruction of the joint. In other cases of a more chronic character, even with pus-formation, the disease is practically painless, swelling, heat and general febrile rise being the only symptoms.

5. When one or more joints become simultaneously swollen, red, hot, painful and tender to pressure and the slightest movement; when, with the local inflammation, there is a high febrile movement with profuse sour-smelling perspiration and with scant, high-colored urine, the condition is acute rheumatic arthritis. If with such conditions there is a history of former attacks the diagnosis is confirmed.

6. When with a history of lithemia a patient is suddenly awakened after midnight with an acute, agonizing pain in one of the small joints, notably the metatarso-phalangeal joint of the great toe; when this pain is paroxysmal in character, the joint becoming swollen, tense, red and exquisitely sensitive; when the pain subsides toward morning only to recur the following night, the condition is acute gouty arthritis. The history of former attacks, of indiscreet living and of a uric acid diathesis will be confirmatory.

7. When following a history of acute serous synovitis or as the result of slight traumatism there is a gradual accumulation of fluid in a synovial cavity; when there are present no symptoms of inflammation such as heat, pain and redness; when, in addition to the swelling, there is a weakness of the joint and a slight impairment of mobility, the disease is chronic serous synovitis.

8. When there is chronic effusion of considerable extent into a joint; when the accumulation is progressive though slow; when there is decided thickening of the capsule, some local heat and, in the later stages, pain and tenderness and possibly slight general elevation of temperature, the disease is tubercular hydrops.

9. When during an attack of syphilis there are pains in the joints and effusions into the synovial cavity in the absence of traumatic or other causes, the condition is syphilitic synovitis. When, with a history of congenital or acquired syphilis or external evidence of such disease there is synovial effusion, either painless or attended by pain which is especially severe at night; when there is an irregular, nodular thickening of the synovial membrane and capsule with the symptoms of chronic inflammation the disease is gummatous arthritis.

10. When a patient with a history of former attacks complains of one or more joints being stiff and sore, the soreness and immobility passing away upon using the limb; when a cracking sound is detected upon movement, as of rough surfaces rubbed together; when the symptoms are all aggravated or even rendered sub-acute by cold damp weather or exposure, the diagnosis is chronic rheumatic arthritis.

11. When an old man begins to notice stiffness and aching in the large joints without any evidence of inflammation; when there is no history of rheumatism and the disease, though very chronic, is progressive and not intermittent; where movement elicits a roughness which gradually increases; where the articular surfaces of the bone become



irregular in shape and nodular in parts not subjected to pressure the disease is arthritis deformans.

12. When there is rapid effusion into a joint in the course of an attack of locomotor ataxia, without the signs of acute inflammation; when, with the effusion, there is a grating upon movement which is rather restricted; when upon absorption of the fluid there is found complete alteration in the shape of the articulation from absorption of the bone and cartilage, leaving a joint preternaturally mobile, the condition is an osteo-arthritis from enervation, or Charcot's disease.

13. When a joint becomes gradually enlarged and the swelling assumes primarily the shape of the articular bones or synovial membrane, but later becomes more or less globular in outline; when there is an elastic feel rather than a decided fluctuation, the skin over the joint being hot but white and shining, the tissues being held rigid and usually flexed, the muscles above and below being markedly atrophied, the condition is tubercular arthritis. Starting pains, the formation of sinuses and the constitutional symptoms are confirmatory.

## CHAPTER VII.

### OPERATIONS ON JOINTS.

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**General Observations.**—In no class of surgery is thoroughness in carrying out the details of surgical sterilization more imperative than in operations on joints; indeed it is to antiseptic methods and local ischemia that most of the advances in technique and improvement in results are due. The operations to be described are aspiration and injection, arthrotomy, arthrectomy and excision.

**Aspiration and Injection.**—This operation is generally termed aspiration although the majority of surgeons now employ a moderate-sized trochar instead of an aspirator. The instrument must have been sterilized either by boiling or by heating in an alcohol flame and the seat of puncture thoroughly cleansed, shaved and rendered aseptic, as for any other operation. The site of puncture should be selected at a point where the joint is superficial and may be entered without endangering surrounding tissues of importance. It is best always to draw the skin a little to one side and render it tense before puncturing, thus making a valvular covering to the deeper parts of the wound. After the fluid is withdrawn, especially if it is purulent or sero-purulent, the articulation should be irrigated by connecting the canula with the tube of the irrigator after being assured that neither contains air. Sterilized water or a mild boric acid solution may be used, the object being to mechanically remove the accumulation. The joint should be distended and evacuated until the water returns pure. Then the injection of the sterilized iodoform-emulsion may be made with a sterilized glass syringe to which has been fastened an antiseptic rubber tube. The quantity should vary with the size of the joint and age of the patient, from two to eight drachms, and may be repeated in one or two weeks. After the injection, passive or active movements should be used in order to bring the medicated fluid into contact with the whole of the serous membrane. Upon the withdrawal of the canula the puncture-hole should be sealed with a collodion dressing.

**Arthrotomy.**—This means an incision into a joint. It is performed usually for acute infective inflammations of the joint, the objects being, as in the treatment of abscesses, thorough evacuation of the retained fluids, the supplying of perfect drainage and the topical application of germicidal lotions. It is also of marked benefit in tubercular joints which have, through sinuses, become the seat of secondary infection. The incision should be made with the idea of conserving nerves, muscles and tendons, as well as arteries, and should be so placed as to insure the most perfect drainage possible. Arthrotomy may also be demanded for the removal of a floating body. After thorough irrigation and establishment of drainage the joint should be surrounded by a moist antiseptic dressing and placed at rest on a splint. The frequency with which the irrigation should be repeated depends upon the amount and character of the discharge.

**Arthrectomy, or Erasion.**—By this operation is meant the removal of the infected soft structures of a diseased joint and the curetting of foci of bone that communicate with the joint. It differs from excision in that all healthy parts of the articular bones are saved. The joint is entered by the same or similar incisions to those used in excision, the diseased tissues are dissected away by means of forceps and a scalpel or by scissors, bone cavities are scraped and sterilized, and the wounds stitched without drainage. The operation is limited in its application to tubercular inflammations, and is especially applicable to those primary synovial forms in adults and all forms in children where typical excision would probably destroy an epiphysis and thus cause imperfect development of the limb. To be of the best service the operation should be performed as soon as the surgeon is satisfied that the intra-articular injections are not effectual, before bone disease is too extensive and before secondary infection has taken place. The incisions must be large enough and so located that every part of the joint cavity can be inspected. Upon the thorough removal of all diseased tissues the success of arthrectomy depends.

**Excision of the Joints.**—The terms excision, resection and excision are synonymous terms used to designate the removal of the articular extremities of bones entering into the formation of the joint. Excision is demanded for tubercular arthritis which has progressed beyond the pale of arthrectomy; for comminuted fractures involving the joints, especially when compound and the result of shot wounds; for ankylosis and deformity, as when the elbow is ankylosed in extension or the knee in flexion. The objects of attainment are: The complete removal of hopelessly diseased or injured structures without the unnecessary sacrifice of healthy tissues; the securing of a useful limb; the prevention or elimination of infection by the strictest adherence to the rules of surgical cleanliness. Excision is a very valuable operation, but, on account of the low rate of mortality incident to modern methods of wound-treatment, it is done too often. Sufficient care is not taken to differentiate between cases calling for incision and drainage, arthrectomy and amputation. The surgeon should always ask himself whether or not nature and rest are able to effect a cure in a given case. Where the social condition of the patient is such that he cannot take the necessary time to rest, where operation will give as good or better functional result than nature, or where deformity can be prevented, operation should be advised. Where these conditions do not obtain it is advisable to wait. An excision should never be done for diseased conditions that can be cured by incision and drainage or by arthrectomy. Too much stress cannot be laid upon the advantage of arthrectomy over excision in children, especially in those joints where excision would remove the most active epiphyses.

When the disease has extended too far for any of these more conservative operations the question between excision and amputation has to be settled. The factors to decide this question are (a) the comparative risk of the two operations; (b) the advantages of the limb left in comparison with an artificial one; (c) the extent and nature of the disease and the general health and social position of the patient. Statistics show that excision is attended by a lower rate of mortality than amputation in the following joints: the shoulder, the wrist, the hip and the knee. Amputa-



tion of the arm and leg in their lower thirds is safer than excisions of elbow and ankle.

The probability of saving a useful arm or hand should incline the choice of excision of the elbow rather than amputation of an arm, although the danger is slightly greater, as it also is in the ankle. If either the astragalus or os calcis can be saved excision is preferable. Where both must be sacrificed and a badly misshapen foot be left, as in excision of the ankle as done by Mickulicz, an artificial foot is more ornamental and useful. In the lower extremity, when the disease involves the bone to such an extent that excision would render it short and less useful than an artificial one amputation is to be preferred. Excision should never be done for malignant disease; and for acute inflammatory diseases added to an existing tubercular inflammation incision and drainage should be the first step, the second one to be decided upon later.

When weakened by an exhausting disease the patient is not in a condition for a long convalescence, and amputation might be deemed best on account of general conditions of health and surroundings.

**General Rules for Operating.**—Free incision is eminently essential. The special incisions will be given later, but where mobility is aimed at the long incision parallel to the axis of the limb is best. Placed thus the scar will not interfere with the after movements of the joint, and the section of important nerves, vessels and tendons is avoided. Small incisions and the employment of much force in blunt dissections may be responsible for many cases of systemic involvement following operations upon tubercular joints—the infective material being forced into the mouths of patent veins and lymphatics. As little of the bone is to be removed as is consistent with thoroughness. Thorough scraping of all carious pockets and the removal of every vestige of diseased soft tissue, with a knife, scissors or sharp spoon, are the important steps. Points that are in the least suspicious-looking had better be removed, and if they cannot well be, they should be sterilized with chloride of zinc, or better yet, in tubercular cases, by rubbing thoroughly with iodoform.

Where a movable joint is the object the periosteum should be saved, also the capsule and tendon insertions, provided they are healthy. On no account should anything that is manifestly diseased be allowed to remain, or the operation will be a failure.

Careful hemostasis is imperative and extra efforts at securing it will well repay the surgeon.

Silk-worm suture is the best material, and the author's best results have been attained by accurate suture, without drainage, and immobilization with plaster of Paris casts.

## CHAPTER VIII.

### EXCISIONS OF SPECIAL JOINTS.

**Excision of the Shoulder Joint.**—Excision of the shoulder joint usually means the removal of the head of the humerus with possible scraping of the glenoid cavity. It may be required for tubercular disease, for compound comminuted fractures as the result of shot injuries, or for old and unreduced dislocations where the joint is not only painful but useless. Excision for simple ankylosis is seldom if ever demanded because the mobility of the scapula compensates for the loss of movement in the joint proper.

**ANATOMY.** The head of the humerus points in about the same direction as the inner condyle and can be felt by deep pressure in the axilla. The prominence of the shoulder felt beneath the deltoid muscle consists of the tuberosities.

The capsule is attached at the anatomical neck. The muscular attachments are the supra- and infra-spinatus and the teres minor to the great tuberosity, the sub-scapularis to the lesser tuberosity and the tendon of the long head of the biceps, passing in the groove on the anterior aspect, to its attachment to the upper part of the glenoid cavity. The nerve supply to this joint is derived from the circumflex and the supra-scapular. It is well to remember that the former curves around the humerus at the level of the surgical neck—the latter has no surgical significance in its relationship to the joint.

The upper end of the humerus develops from two centers of ossification; one for the head proper, which appears in the first year and unites with the tuberosities in the line of the anatomical neck at the age of five years; and one for the tuberosities, which appears between the second and third year, unites with the head at five years and joins the shaft at twenty years.

The length of the humerus is due mainly to the growth from this epiphysis.

Hemorrhage is to be controlled by an elastic band passed round the shoulder, compressing the artery against the neck of the scapula. It should pass high up in the axilla and over the clavicle, internally to the coracoid process, and should be fastened either by tying or by carrying it around the body beneath the opposite arm. The patient should be placed

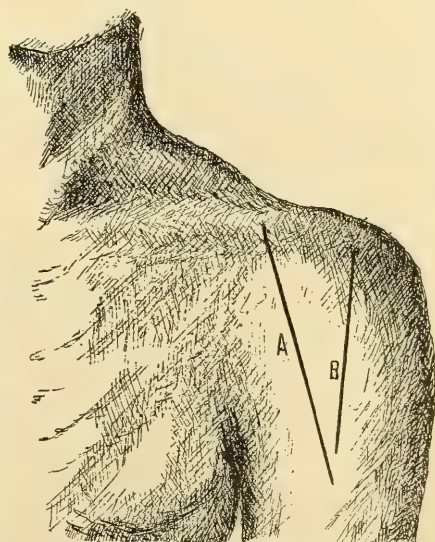


Fig. 54. Excision of Shoulder Joint. Lines of Incision.

on his back, the shoulders well raised, with the diseased shoulder projecting beyond the side of the table toward the surgeon, and the arm supported in slightly abducted position by an assistant. A three or four inch incision is made extending from the clavicle, above and a trifle externally to the coracoid process, obliquely downward and outward along the border of the deltoid muscle. (Fig. 54, A.) This incision is external to the cephalic vein and descending branch of the acromial thoracic artery, which lie in the groove separating the deltoid from the pectoralis major. Cutting through the skin and fascia the anterior border of the deltoid is exposed and drawn outward, thus exposing the capsule and the muscles passing up to the coracoid process. By inward rotation of the arm the sheath of the long head of the biceps is brought into view. The tendon should be dissected out from the groove and drawn outward with the deltoid by means of blunt retractors. The capsule is incised by a horse-shoe incision thus: The assistant rotates the arm strongly inward (in the right shoulder excision) bringing into view the muscles attached to the great tuberosity, i. e., the supra- and infra-spinatus and the teres minor. These are severed by an upward sweep of the knife, which is then carried in a curve across the head of the bone as the assistant slowly rotates the arm outward, bringing into the line of the descending cut the tendon of the sub-scapularis at its insertion into the lesser tuberosity. By this horse-shoe incision the tendons and capsule are severed at once. In the left shoulder the manipulations are reversed, the external rotation coming first and the sub-scapularis tendons severed in the upward sweep. If the bone must be further exposed in order to remove all the disease the assistant must force the head well out of the incision while the surgeon carefully separates the capsule and other soft tissues around the posterior portion, being ever mindful of the locality of the circumflex nerve and the anterior and posterior circumflex arteries. The bone is sawn through below the extent of the disease. The glenoid cavity should be thoroughly examined and the diseased foci, if any exist, either scraped or chiseled away, diseased soft tissues thoroughly removed with scissors and forceps, counter-opening made behind for drainage and the wound united with silk-worm suture. The posterior drainage is far better than drainage at the lower angle of the incision. It is most safely provided by blunt dissection through the deltoid with dressing forceps, carefully avoiding the posterior circumflex artery. When the point of the forceps appears beneath the overlying skin is cut down upon, the forceps pushed through, opened and a good-sized drainage tube drawn into the cavity. A large antiseptic dressing should then be applied, a wedge-shaped pad with the base uppermost placed in the axilla, to prevent the upper part of the shaft drawing inward, and the whole arm bound to the chest. Movements of the wrist and fingers may be allowed after the first change of dressing but passive movement of the shoulder must be positively forbidden until the wound is healed.

**THE SUB-PERIOSTEAL METHOD.** This is suitable only for old unreduced dislocations or injuries. The steps are the same as already described until the exposure of the capsule and the dissecting out of the long head of the biceps begin. The capsule in this operation is incised vertically and the same incision made to cut the periosteum down to a point as low as it is thought best to remove the bone. The knife is



then laid aside and the dissection continued with a periosteum elevator. The arm being first rotated to bring the great tuberosity into view the muscular attachments are severed, even if a thin slice of bone must be chiseled off in order to accomplish this end. The lesser tuberosity is treated in a like manner, the head thrust through the opening, the remaining attachments severed and the bone sawn.

The sub-periosteal method should be preferred where practicable, as the functional result is naturally better still; soft tissues that are manifestly diseased should never be left.

According to Treves more than two-thirds of these cases recover with useful limbs.

Other lines of incisions which may be used are the vertical incision of Langenbeck (Fig. 54, B), and by the reflection of a flap consisting of the deltoid muscle. Both incisions inflict unnecessary harm upon the deltoid muscle and the latter, especially, upon the circumflex artery and nerve.

**Excision of the Elbow.**—This operation is most frequently required for tubercular arthritis, though it may also be demanded for compound and comminuted fractures or compound dislocations, and for osseous ankylosis.

**ANATOMY.** The bones entering into the formation of this joint are the humerus, the radius and the ulna.

The lower epiphysis of the humerus develops from four centers, two for the articular surface proper and one each for the condyles; the former two are within the joint capsule. They all unite with the shaft from the sixteenth to the eighteenth year, that for the inner condyle being the latest. The upper epiphysis of the radius is really the head of that bone. It ossifies from a single center which appears at five and joins the shaft at puberty. It is entirely within the synovial membrane. Most of the olecranon process of the ulna is from the shaft, but there is a small epiphysis at the very upper part which begins to ossify about the tenth year and joins the shaft at sixteen. As the humerus develops mainly from its upper and the radius and ulna from the lower epiphyses the development is not so markedly interfered with in case of the excision of the elbow in children. The anterior and posterior portions of the capsule have least strength. The lateral ligaments are very thick and firm. The chief muscular attachments with which we deal in this excision are the triceps to the olecranon; the biceps to the radial tuberosity; the brachialis anticus to the coronoid process of ulna and below it; the anconeus to the external condyle and olecranon, and the supinator brevis in its extensive attachments to all three bones as well as to the ligaments. The common tendons of origin from the condyles are also disturbed. The two nerves most intimately concerned are the ulnar, which lies in a groove between the inner condyle and the olecranon, accompanied by the inferior profunda artery, and the posterior interosseous where it pierces the supinator brevis and winds around the head of the radius to reach the posterior muscles of the forearm.

**OPERATION.** The patient being drawn close to the edge of the table and artificial ischemia induced by circular constriction of the upper brachial artery, the arm should be carried across the patient's chest and intrusted to the care of an assistant.

The surgeon stands at the patient's side corresponding to the diseased

arm and makes a median posterior incision four inches long, extending from above the olecranon fossa of the humerus along the olecranon process and the posterior border of the ulnar shaft. (Fig. 55, A.) The incision is carried down to the bone for its full length. As Kocher says: "The resection is correct in proportion to the thoroughness with which the bone is laid bare." Working slowly and cautiously, the arm being now extended, the triceps tendon and the common tendon of the extensors are separated from their attachments. This separation should be periosteal and done by means of a periosteum elevator, the knife being used when necessary only. This will expose the external condyle and the head of the radius and relax the tissues so that the more difficult dissection of the ulnar side can be more readily made. The inner part of the triceps and the common flexor tendons, together with the pronator teres, are then separated, the knife or elevator closely hugging the bone lest the ulnar nerve be injured. After the dissection is complete the arm must be firmly

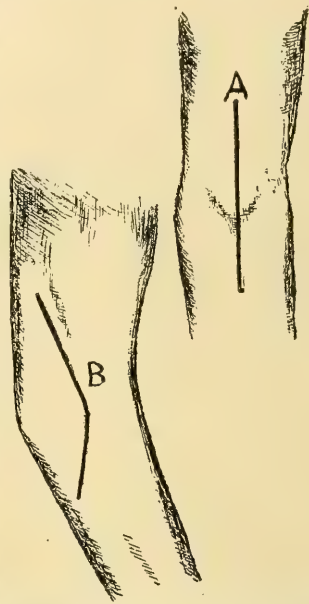


Fig. 55. Excision of Elbow Joint. Lines of Incision.

flexed, the lateral ligaments divided close to their humeral attachments and the humerus sawn through in a line parallel to the articular surface. The bones of the forearm are then forced out of the wound, the orbicular ligament severed, the brachialis anticus partially detached if necessary to expose the whole of the articular surfaces, and the bones sawn through. Many surgeons prefer early section of the olecranon, claiming it renders the exposure of the other bones more easy. The radius, too, may be divided with bone forceps. The diseased soft tissues are then carefully removed either by cutting or by scraping a counter opening sufficiently large for adequate drainage, made on the inner side, and the longitudinal wound completely closed after the removal of the constrictor and the ligation of the divided arteries. A large antiseptic dressing is then applied and the patient put to bed. The arm should be placed on a pillow in that position which will insure the greatest degree of comfort.

Until drainage tubes can be dispensed with splints are not necessary, unless to steady the limb. In a week or ten days an external splint with a hinge at elbow joint may be used, and the arm dressed at times at a right angle and again only slightly flexed. After the healing of the primary incision passive movements—flexion, extension, pronation and supination—must be practiced daily, always avoiding severe pain. The other lines of incision recommended are the H incision, and the external curved incision of Kocher. (Fig. 55, B.)

To insure a false joint a separation of at least one-half inch should be maintained between the bones. Extension may at times be required. If ankylosis is either desired or apparent after an operation it should be secured in the right-angled position. The results are usually satisfactory,

the mortality being very slight since the introduction of *modern* methods of wound-treatment.

**Excision of the Wrist.**—The complete operation for excision of the wrist includes the removal of all the carpal bones, of the lower ends of both radius and ulna, as well as of the articular ends of the metacarpal bones. It is required most commonly for tubercular disease of the wrist or carpal bones, though rarely it may be demanded as the result of compound and comminuted fractures. The essentials to the success of this operation are a knowledge of anatomy, that no tendons may be needlessly sacrificed, the radical removal of all the diseased bones and cartilages, and prevention of ankylosis of the joints of the fingers and thumb.

**ANATOMY.** The lower epiphysis of the radius begins to ossify during the second year and joins the shaft at the age of twenty. It is entirely within the synovial membrane and includes the styloid process for the attachment of the supinator longus.

The lower epiphysis of the ulna is only partly intra-synovial; it begins to ossify at the fourth year and unites with the diaphysis at twenty years. The carpal bones become ossified from the first to the twelfth year. The epiphysis of the metacarpal bones, with the single exception of the first, are at the distal extremity or head and so play no part in this operation.

The wrist joint is curved with the convexity upward, so that a line joining the styloid processes of the radius and ulna is almost one-half an inch below the upper part of the joint.

The external, the internal and the anterior ligaments, the latter especially, are very strong, but the posterior is less substantial. In a total excision the separate synovial membranes of the carpus have no significance. The tendons surrounding the joint are many and important, and most of them are enveloped by synovial sheaths. On the posterior surface going from the radial to the ulnar side these tendons may usually be made out as follows: Extensor secundi internodii pollicis; the extensor primi pollicis, the extensor indicis and then the common extensors and extensor minimi digiti. On the inner side are the flexor and extensor carpi ulnaris, on the outer side the two radial extensors and the extensors of the metacarpal bone. In front from the radial to the ulnar side the flexor longus pollicis, the flexor carpi radialis, the palmaris longus, the common flexors and the flexor carpi ulnaris. The radial artery lying between the tendons of the supinator longus and the flexor carpi radialis above winds around the wrist below the styloid process, resting upon the external lateral ligament, runs back over the scaphoid and trapezium and is very near the articulation of the latter bone with the first metacarpal bone. As the ulnar artery, with the nerve on its inner side, lies between the tendons of flexor carpi ulnaris and the flexor sublimis digitorum it is out of harm's way. Branches of the posterior carpal arches will probably be cut and must be ligated.

**OPERATION.** The rubber constrictor being applied to the brachial artery and all adhesions being broken up the patient's hand is rested upon a pad or sand-bag and held in a pronated and flexed position by an assistant.

An incision is begun at the middle of the dorsal surface of the radius one-half an inch above the articulation and just to the ulnar side of the



tendon of the extensor secundi pollicis. It should be carried downward parallel to this tendon to the base of the second metacarpal bone, then along the shaft of this bone to about its middle. (Fig. 56, A.) This incision, carried clear to the bone, severs only one tendon—the extensor carpi radialis brevis. Care must be exercised not to prolong the oblique part of the incision beyond the base of the second metacarpal bone lest the radial artery be injured. The soft tissues on the radial side of the incision are then to be carefully separated, the hand being bent backward so as to relax them. The tendon of the long radial extensor must be severed from its attachments to the second metacarpal bone and the other tendons, the second and first extensor of the thumb, that of the first metacarpal bone and the supinator longus, may be separated and preserved. The structures on the ulnar side are then separated as far as possible and another incision made along the inner border of the wrist extending from one and one-fourth inches above the styloid process of the ulna to the middle of the fifth metacarpal bone. (Fig. 56, B.) From this incision the rest of the dorsal tendons are easily separated, the extensor carpi ulnaris being severed at its attachment to the fifth metacarpal bone. The posterior and lateral ligaments of the joint are then severed, the hand strongly flexed and the separation of the palmar tissues begun. The dissection should be as close to the bone as possible, thus avoiding the ulnar nerve and artery, and must not extend below the bases of the metacarpal bones lest the deep palmar arch be injured.



Fig. 56. Excision of Wrist and Finger. Lines of Incision.

If the pisiform bone is not diseased it is wise to leave at least a portion of it with its attached tendon, and the process of the unciform bone may be snipped off with bone forceps. The anterior ligament is then divided. The order of removal of the bones is a matter of choice with the individual operator. As the carpal bones are the most difficult to remove the author's preference is to make the early section of the radius and ulna by causing their protrusion through the wounds and dividing with a fine saw, thus giving more room and greater freedom of mobility for the more-difficult task of dissecting out the carpus without undue damage. The metacarpal bones are then carefully projected and as little removed as possible, consistent with thoroughness, avoiding the deep palmar arch. The wounds are to be carefully sutured, thoroughly drained, antiseptically dressed and placed at rest upon a splint so arranged that the wrist may be extended and the fingers flexed. Olliers' wire splint serves the purpose admirably. The splint fixes the wrist, prevents the tendency to flexion and adduction of the hand, and at the same time permits of both passive and active motion of the fingers from the day after the operation. The object of attainment is a fibrous union in a good

position without adhesion of the extensor and flexor tendons. The most essential factors in its attainment are a wound free from external infection, and the early passive and active movement of the fingers while the wrist is maintained rigidly fixed.

The dorso-ulnar incision as proposed by Kocher passes between the extensor communis digitorum and the extensor minimi digiti, opening the capsule of the joint opposite the base of the fourth metacarpal bone. (Fig. 56, C.)

Ollier's incisions are similar to those already described and illustrated in Fig. 54.

**Excision of the Metacarpo-Phalangeal and Inter-Phalangeal Joints.**—These operations are not of frequent occurrence, the removal of sequestra or of an entire phalanx being more common. The operation may, however, be demanded either for injury or disease.

**ANATOMY.** The only necessary points to remember are that in the four inner metacarpal bones the epiphyses are at the distal end and form the head; but of the first, the epiphysis is at the proximal end. They begin to ossify on the third year and unite with the shaft at the age of twenty years. The epiphyses of the phalanges appear also at the third year, constitute the base, that is the proximal end, and unite with the shaft at twenty. Excision of the metacarpo-phalangeal joint of the fingers, then, would remove both epiphyses and, if done in early life, stop the growth of bones.

**OPERATION.** It may be done by a single lateral or dorsal incision or by bilateral incisions, requisite care being observed to avoid the tendons and nerves (Fig. 56, BB, CC.) The soft structures are separated with blunt instruments and the bones sawn off as in any excision. The operations are not satisfactory, being so often followed by complete ankylosis or by a flail-like joint.

**Excision of the Hip Joint.**—By excision of the hip joint is usually meant the removal of the head of the femur, although the acetabulum is frequently gouged, scraped and even largely chiseled away. The operation is nearly always done for tubercular disease of the joint though it may possibly be demanded for injuries. Excision should never be performed for ankylosis, osteotomy, as already described, being far more satisfactory.

**ANATOMY.** The joint is deeply placed and is surrounded by thick muscles. The upper surface of the trochanter is opposite the center of the acetabulum. The head of the femur is just to the outer side of the center of Poupert's ligament and a little below it. The capsular ligament surrounds the acetabulum, being attached to the pelvis about one-quarter inch external to the cotyloid ligament or cartilage. It is attached below to the anterior inter-trochanteric line, to the base of the great trochanter on top of the neck, but behind to the middle of the neck one-half inch above the posterior inter-trochanteric line. The capsule is weakest at the lowest and posterior portion. The ligamentum teres is surrounded by synovial membrane but is not intra-articular. The main muscular attachments are in front, the psoas and iliacus to the lesser trochanter. Between the tendon and the capsule is a bursa which sometimes communicates with the joint. The attachments of the gluteus medius and the reflected tendon of the rectus are to the outer side and above; the gluteus



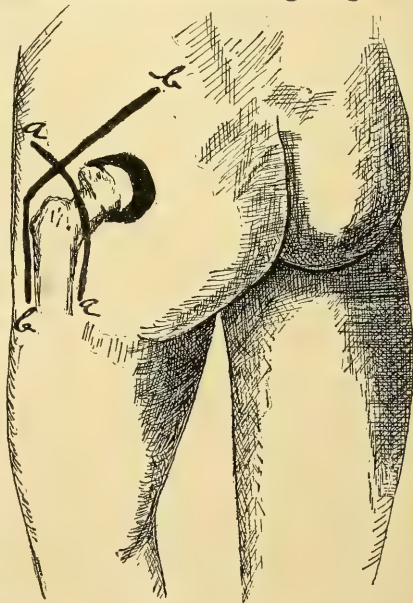
minimus to the anterior border of the great trochanter, the obturator internus, the quadratus femoris and the pyriformis above and behind, while below and to the inner side are the obturator externus and the pectineus. The upper part of the femur develops from three centers of ossification, one for the head appearing in the first year, one for the great trochanter appearing at the fourth year, and a third for the lesser trochanter, which appears in the thirteenth year.

They all join the shaft at the age of eighteen. The shaft of the femur develops in length chiefly from the lower epiphysis. The acetabulum has in addition to the centers of the bones entering into the formation, one for the Y shaped cartilage uniting said bones. It appears at the age of fourteen and becomes completely ossified at twenty-five years.

The nerve supply to the hip joint is derived from the obturator, accessory obturator, the sacral plexus and the great sciatic. The arteries are branches of the obturator, gluteal, sciatic and circumflex.

**OPERATION.** The patient lies upon the sound side, the thigh is flexed, adducted and rotated in and intrusted to an assistant. The surgeon should stand in front of the patient's face and his first assistant at the opposite side facing the patient's back. The operation by the posterior curved incision is, in the majority of cases, the most suitable, giving the most ready access to the joint and affording the best drainage where mixed infection is present. This operation is open to the objection of greater muscular section than the external incision of Langenbeck, as modified by Kocher.

The incision beginning at the point midway between the anterior superior spine of the ileum and the great trochanter curves around the upper and posterior borders of that prominence and terminates from one and one-half to two inches below it, eight lines behind the shaft of the femur. (Fig. 57, a.) This incision should be carried through the glutei muscles for its full length, thus thoroughly exposing the capsule. Retractors are introduced, and, the soft parts being held aside, the capsule is divided by cutting up on the head



of the femur near the acetabulum and in the direction of the skin incision. The cotyloid ligament is then nicked in many places by introducing the knife into the joint flatwise and then turning the cutting edge toward the acetabulum and carrying it down to the margin of that cavity. This loosens the tissues so that air enters and a knife is easily introduced into the joint cavity, the edge being directed toward and against the ligamentum teres, which is easily severed by the assistant gently rotating the limb while the knife is held stationary. The limb is next rotated outward and the anterior structures loosened, when forcible

Fig. 57, a. Posterior Curved Incision for Excision of Hip Joint.  
b. Kocher's Modification of Langenbeck's External Incision.



inner rotation will throw the head of the bone out as with backward dislocations. The structures are carefully examined, the extent of the disease determined and the soft parts protected while the bone is sawn from within outward. The capsule, if diseased, must then be removed and the acetabulum and all sinuses, if any exist, be thoroughly curetted and sterilized by irrigation and sponging. The soft tissues are then to be sutured, drainage introduced, if thought necessary, and a large antiseptic dressing applied. The patient should have a firm level mattress and the limb be maintained at perfect rest by means of a long external splint with extension, or, where the latter is not necessary, by a plaster cast. The author's

preference where suppurative infection has not reached the already existing tubercular disease is very thorough hemostasis, after perfect sterilization, drying the wound absolutely, dusting it with iodoform and, after accurate suture, the application of a plaster cast. When the trochanter is diseased and must be removed, or in cases where a sub-periosteal excision can be practiced, the external incision modified by Kocher, as shown in Fig. 57, b., is preferable. This incision begins at the base of the outer surface of the great trochanter and passes obliquely up to the anterior point of that process, and thence upward and backward in the direction of the fibres of the gluteus minimus to a point one and one-half or two inches above the rim of the acetabulum. The soft tissues are separated close to the bone—the periosteum being raised whenever possible—the capsule is opened by a longitudinal rather than a transverse incision and the operation completed as above described.

The anterior incision of Barker (Fig. 58, A) commences at a point half an inch below the anterior superior iliac spine, passes obliquely downward and inward directly between the sartorius and rectus on the inner and the gluteus and tensor vaginae femoris muscles on the outer side. No muscles are divided in this incision, the deeper dissection being made by retracting the muscles above named. Arthrectomy may be done through either of the last two incisions.

**Excision of the Knee Joint.**—This operation calls for the removal of the articular surfaces of the femur and the tibia. It is frequently required for tubercular disease of the joint, for osseous ankylosis in a flexed position, and occasionally for traumatic injuries.

**ANATOMY.** The joint derives its strength mainly from the ligaments and tendons which unite and surround the bones entering into its formation. The crucial



Fig. 58. Excision of Hip and Knee Joints:

A and B, Lines of Incision.

unite and surround the bones entering into its formation. The crucial

ligaments are of special strength though, in a sense, within the articulation they are not intra-synovial. The anterior and posterior ligaments are more powerful than the lateral. The synovial membrane extends as a pouch two or two and one-half inches above the patella beneath the quadriceps tendon. It also extends below the patella one-third the length of the patellar ligament. In addition to the ligaments already mentioned the only ones apt to be disturbed in this operation are the ligamentum patella or the tendon of the quadriceps, depending upon whether the incision is made below or above the knee-cap.

The lower epiphyseal line of the femur is at the level of the adductor tubercle which, in a child, is not more than from one-half to three-quarters of an inch from the articular surface. The center of ossification of this epiphysis is present at birth. It joins the shaft at the age of twenty years. The length of the femur depends largely upon this epiphysis, which is practically within the articulation. The epiphysis of the tibia includes both tuberosities and slopes down anteriorly so as to include the tibial tubercle. It joins the shaft at the age of twenty-five, only a small portion of it being intra-articular. The tibia grows in length mainly from its upper epiphysis. This should always be borne in mind in recommending operations upon the knee joint in children, the active epiphysis of the leg being practically destroyed if the femur is sacrificed at or above the adductor tubercle, and the tibia below the tuberosities. The bursæ are of interest in connection with this joint, because they are frequently connected with the general synovial membrane, are those beneath the lower two-thirds of the ligamentum patella and that between

the inner condyle of the femur and the semi-membranosus. There is also a bursa beneath the popliteus which may not only communicate with the knee joint but also with the superior tibio-fibular joint. There is little danger of wounding the popliteal vessels and nerves. The joint is supplied by branches from the obturator, the external and internal popliteal and the anterior crural nerves.

**OPERATION.** The femoral artery being constricted, the patient lying upon the back, the knee is flexed so that the foot rests firmly upon the table. Being held in this position by an assistant, the surgeon, standing on the right side of the patient, makes a U shaped flap with the convexity downward. Beginning at the posterior margin of one condyle of the femur it passes directly downward to the level of the lower edge of the patella, thence in a gentle curve across the front of the leg midway between the patella and the tibial tubercle, and then upward to the posterior margin of the other femoral condyle. (Fig. 59, AA.)

By this incision the integuments and the patellar tendon are severed and the patella included in the reflected flap. The knee is now forcibly flexed and the lateral ligaments and the crucial ligaments cut. These latter should be divided by directing the knife against the tibia. The femur is

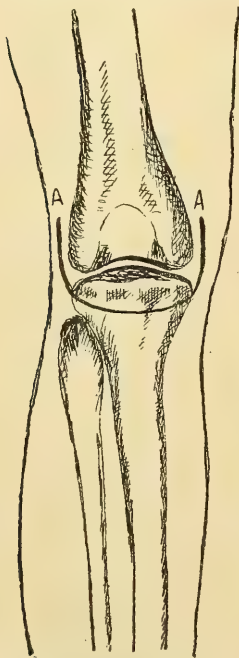


Fig. 59. Excision of Knee Joint. Line of Incision.

then cleared at the point of application of the saw, and the bone divided in a line parallel to the articular surface from side to side but at right angles to the axis of the limb, antero-posteriorly. The head of the tibia is then cleared and the bone section made parallel to the articular surface. This is most easily accomplished and with the least possibility of error if the foot be firmly planted upon the table and the saw be held perfectly level. The diseased synovial membrane is now dissected away, using all efforts to preserve the posterior ligament to prevent infection of the popliteal space. The patella being of no use is removed, all sinuses and diverticula are carefully curetted or dissected out, and drainage tubes are introduced laterally if required at all. The wound is carefully sterilized and dried, silk-worm sutures are introduced, a large antiseptic dressing is applied and the bones brought ac-

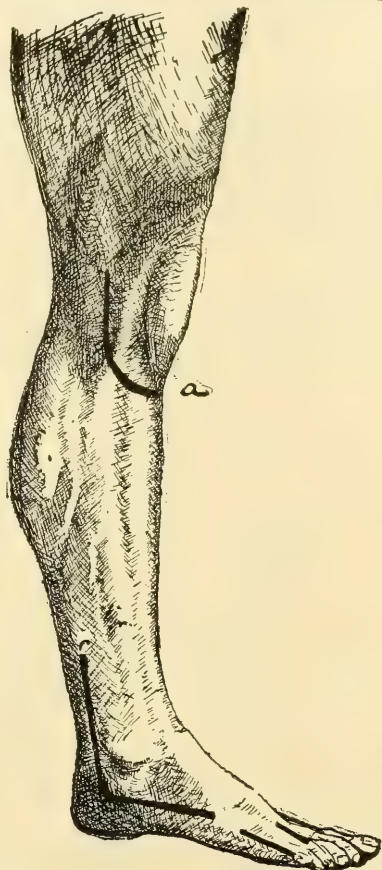


Fig. 60. a. Lateral View of U Incision for Knee Joint Resection. c. External Incision for Total Tarsal Resection.

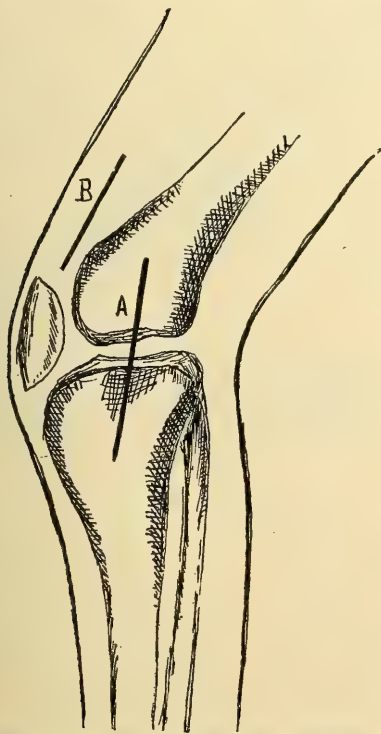


Fig. 61. Lateral Incision for Drainage.

curately together so as to leave a straight limb. If the bones are correctly divided, as described, this is a matter of no difficulty and this point should always be determined before introducing the sutures. There is nothing gained and may be a great deal lost by attempting to unite the bones so that the limb will remain slightly bent. No pins or sutures are necessary to hold the bones in opposition. Position is secured by the careful application of a plaster cast extending from the toes to the thigh. In arthrectomy or even in excision when the disease seems most extensive beneath the quadriceps tendon, the U incision above the patella renders the dissection less difficult. (Fig. 58, B.)



The advantages of arthrectomy or a typical excision over excision proper in the knee joint, whenever it can be practiced, and especially in children before the attainment of full growth, cannot be too strongly urged. If the joint capsule can be dissected away without opening the sac it is a beautiful operation, would be strictly aseptic and require no drainage. Where sinuses have formed it is, of course, impracticable. Incisions for the purpose of drainage may be made laterally as in Fig. 61, A and B.

**Excision of the Ankle Joint.**—The operation for removal of the tarsal bones and sawing off the articular surfaces of the metatarsal bones as well as of the tibia and fibula has little to commend it, amputation above the ankle being far more satisfactory in its results, and an artificial foot of equal or even greater advantage than the remaining stump. The operation as described here will be limited to the removal of the articular surfaces of the bones of the leg and of the astragalus. Even though the latter bone be entirely sacrificed the operation may be proper, but the author has had much better results from arthrectomy of this joint and the removal of diseased foci in the bones by gouging. The keynote to the success of either operation is maintaining the right-angle position during the repair. The operation may be done for disease or for comminution of the malleoli and astragalus.

**ANATOMY.** The shape of the articulating bones and the number and strength of the ligaments and tendons about the ankle joint make it one of great strength. The lateral ligaments are very strong and the weaker anterior and posterior ones are supported by the tendons. The bones entering into the joint formation are the tibia and fibula above, and the astragalus below. The joint is one-half inch above the tip of the internal and one inch above the tip of the external malleolus. The lower epiphyses of the tibia and fibula include the articular surfaces and the corresponding malleolus. They join the shafts at the age of twenty, the centers of ossification appearing during the second year. The synovial membrane pouches both anteriorly and posteriorly, above and below the limits of the articulation, and it is in these places that the intra-articular accumulations are first noticed. The structures passing behind the inner malleolus are, from within outward, the tibialis posticus, the flexor longus digitorum, the posterior tibial artery and nerve, and the flexor longus pollicis; on the outer side the peroneus longus and brevis; anteriorly, from within outward, the tibialis anticus, the extensor proprius pollicis, the dorsalis pedis artery, the anterior tibial nerve and the extensor longus digitorum. The nerve supply is derived from the anterior tibial. The six separate synovial membranes of the tarsus have little importance in connection with this joint.

**OPERATION.** The external lateral incision is the best method. The patient lying on the back the foot is placed with the inner side resting upon a firm pillow or sand-bag. It is held in this position by an assistant while the surgeon, standing on the side corresponding to the diseased foot, makes an incision along the posterior edge of the fibula, curving around the external malleolus and terminating on the cuboid bone. The incision extends two or two and a-half inches above the tip of the malleolus and one and a-half or two inches in front of it. (Fig. 62, a.) The peronii tendons exposed by this incision are drawn aside, the three fasciculi of

the external ligament severed, the capsule entered and divided as far as possible and the foot forcibly luxated inward. To accomplish this luxation so as to completely expose the joint the peronii tendons may have to be severed; if so they should subsequently be sewed. If an arthrectomy is to be done the internal lateral ligament may be left intact; if an excision it must be carefully divided, the vessels, tendons and nerves passing behind it being carefully guarded.

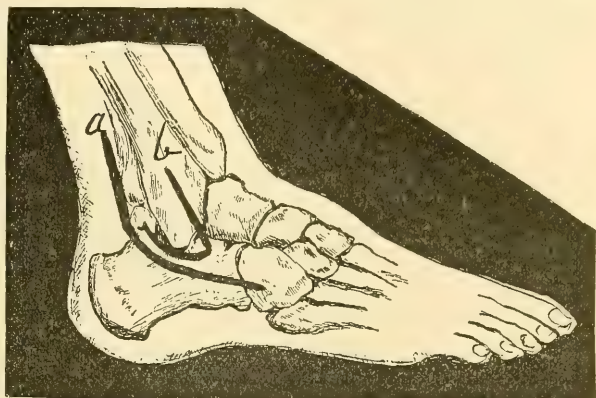


Fig. 62. Excision of Ankle Joint. Lines of Incision.

The astragalus is easily cleared and either removed or the diseased portion sawn or chiseled away. The tibia and fibula are also cleared and sawn at right angles to the axis of the leg. The diseased soft structures are carefully dissected away, the wound

sterilized and dried, severed tendons sutured, and the wound edges approximated with or without drainage, according to the condition of the structures. The foot is enveloped in a large antiseptic dressing and fixed by a plaster of Paris bandage at right angles to the leg. It must be maintained so until perfect osseous union has taken place, or for from two to three months, before the patient should be allowed the use of the foot.

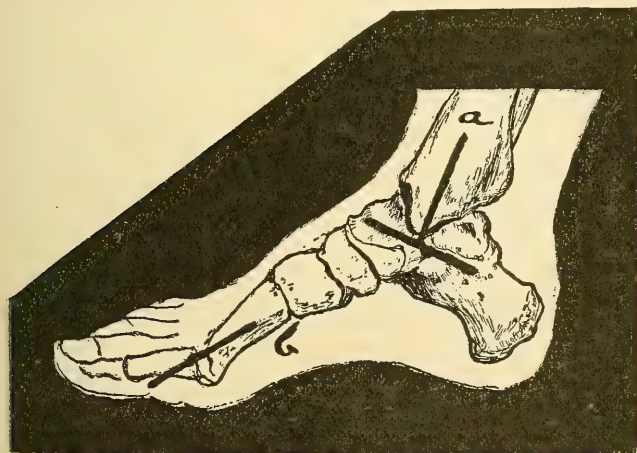


Fig. 63. a. Excision of Ankle Joint. Line of Incision.  
b. Excision of Metatarso-Phalangeal Joints.  
Line of Incision.

The other incisions recommended are the two lateral incisions. The external one is shown in Fig. 62, b, the internal one in Fig. 63, a. The details of the operation are the same as above described.

Kocher recommends the external lateral transverse incision (Fig. 64), extending across the tip of the external malleolus from the tendo Achillis to the extensor tendons. The capsule is severed from the peroneus tertius to the external malleolus, the external lateral ligament divided, the foot luxated inwardly and the operation finished as above.

The total tarsal resection by which the severed metatarsal bones are brought in contact with the sawn surfaces of the tibia and fibula—after



Fig. 64. Ankle Joint Excision. Kocher's Line of Incision.

Mickulicz—may be performed by the external incision prolonged, (Fig. 60, c) thus avoiding the sacrifice of the soft structures of the heel and the posterior tibial vessels and nerves, which are lost in the original incisions.

The excision of tarsal bones and the various osteotomies come under Surgery of the Osseous System.

**Excision of the Metatarso-Phalangeal Joints.**—With the single exception of that of the great toe excision of these joints is rarely practiced. The rules governing the operation, should they be called for, are the same as recommended for the hand, the development and ossification being practically the same. The line of incision for the excision of the first metatarso-phalangeal joint (Fig. 63, b) is the internal lateral. The operation may be called for in cases of hallux valgus and when supuration has extended from an infected bunion; but free incision, curetting and perfect drainage will usually be found most satisfactory in the latter. No special description is necessary.



## SECTION XI. FRACTURES AND DISLOCATIONS.

### CHAPTER I. FRACTURES.—GENERAL CONSIDERATIONS.

**Definitions.**—By fracture is meant the breaking of a bone or cartilage, thereby destroying its continuity. Ordinarily the term is applied to bones alone; and, besides the divisions complete or partial, transverse, longitudinal, oblique and serrated, single, multiple, comminuted, impacted and impacted with crushing, compound, complicated and gun-shot, the terms simple, pathological and ununited are used.

A pathological fracture is one which occurs after some destructive change has taken place in any portion of the bone.

An ununited fracture is one in which bony union has not occurred after the time ordinarily allowed for the repair of fractures.

Partial or incomplete (green-stick, see Fig. 65) is a division including fractures which are simply fissures, fractures in which a bending of the bone takes place, and fractures which are known as perforating fractures. The bone is not broken through its entire thickness, but simply bends on the side against which the force is expended and then splinters on the opposite side. Fractures of the ribs are often of this variety, especially

when the injury is received at either end of the rib and the break occurs at the center of the rib. A blow on the skull will often fracture the inner table, but not affect the outer one beyond causing a depression of the outer table.

In a complete fracture the bone is divided through its entire thickness. (Fig. 66.)

A fracture is



Fig. 65.  
Green-Stick  
Fracture.



Fig. 66.  
Complete  
Fracture.

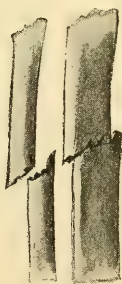


Fig. 67.  
Oblique and Ser-  
rated Fracture.

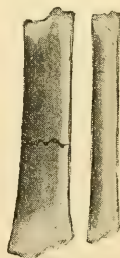


Fig. 68.  
Transverse  
Fracture.

verse (Fig. 68) when there is no apparent obliquity (Fig. 67) of the fragments. The fractured surfaces are not serrated and are usually found in apposition, but at the same time they are freely movable. A

longitudinal fracture (Fig. 69) is one in which the line of division runs for a greater or less distance parallel, or nearly so, with the long axis of the bone.

“V” shaped (Fig. 70) and “T” shaped fractures are not uncommon. Examples of these fractures are often seen in fractures of the tibia and the lower end of the humerus.

A single or simple fracture is one in which the bone is divided at only one point (Figs. 71 and 72).

A multiple fracture is one in which the bone is broken at two or more points. The lines of fracture do not connect; but, in the leg and forearm—where both bones are broken and each only once—these injuries cannot be called “multiple.” A fracture in order to be multiple must have two lines of division in the same bone and the lines of separation must not connect (Fig. 73).



Fig. 69.  
Longitudinal  
Fracture.



Fig. 70.  
“V” Shaped  
Fracture.



Fig. 71.  
Simple or Single  
Fracture.

A comminuted fracture is one in which the bone is splintered or broken into many pieces. The lines of separation communicate (Figs. 74 and 75.)

An impacted fracture is one in which the fragments are held firmly fixed, and is produced by the force of the injury driving the broken ends of the bone together after the fracture has taken place (Fig. 77).

Impacted fractures with crushing resemble somewhat impacted fractures. The lines of division occur at the spongy ends of the bone and, although

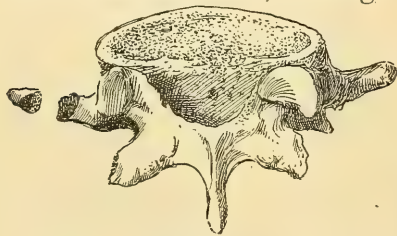


Fig. 72.  
Simple Fracture—Author's Case,  
Obtained Post-Mortem.



Fig. 73.  
Multiple  
Fracture.



Fig. 74.  
Comminuted  
Fracture.



Fig. 75.  
Compound Comminuted Fracture.  
—Bishop.

the fragments are forcibly jammed together, some motion still exists at the seat of partial impaction (Fig. 76).

A compound fracture is one in which from laceration of the overlying soft tissues communication between the atmosphere and the seat of fracture has been established (Fig. 78). Compound fractures may be produced by the tilting-outward and over-riding of the fragments, and hence the wound may be made from within outward, instead of from without inward, as is ordinarily the case in compound

fractures. Little laceration of the tissues follows such an injury when produced by the sharp end of the broken bone, and the wound produced is a punctured one rather than lacerated.

A complicated fracture is one in which severe injury to the soft tissues or viscera is associated with one of the other named varieties of fractures. A nerve may be pressed upon or a blood vessel ruptured,

the pleura may be punctured, or extensive injury to the muscles and cellular tissue may take place in a complicated fracture.

**GUNSHOT FRACTURES.** These do not constitute, properly speaking, one of the great divisions or varieties of fracture. Gunshot fractures combine all the bad features of a compound fracture and a complicated one (Fig. 79). Important nerve trunks and blood vessels may be injured, or portions of the viscera destroyed.

**Displacements.**—Transverse, longitudinal or any other variety of displacement (Fig. 80) may accompany this injury. The deformity which may result from the contractions of the muscles will not differ materially in this form of fracture from any of the other varieties. The prognosis in gunshot fractures should be very guarded and the same treatment as advised for compound fractures should be followed. The needless and prolonged probing of wounds should be discouraged.

The best classification of the forms of displacement of the fragments in any fracture is that suggested by Malgaigne, as transverse or lateral; angular; rotary; over-riding; impactions; longitudinal separation.

The transverse displacement seldom occurs alone and is usually associated with over-riding or angularity (Fig. 80). It may be partial or complete. When the fracture is caused by muscular contraction alone the line of separation is invariably transverse.

An angular displacement will occur not only when the bone is completely broken but when it is partially fractured as well. The force of

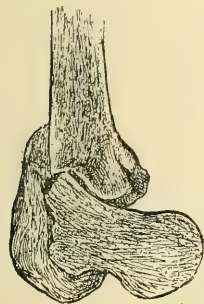


Fig. 76.  
Fracture Combined with Crushing and Impaction.

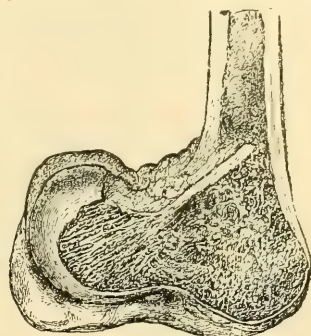


Fig. 77.  
Fracture with Impaction.

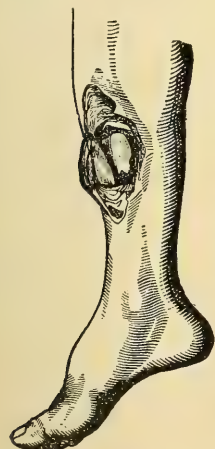


Fig. 78.  
Compound Fracture.



Fig. 79.  
Gunshot Fracture.



gravity acting upon the unsupported fragments will cause angular displacement, and the contraction of certain muscles or groups of muscles will also produce angularity.

A rotatory displacement is one which is common in fractures about the neck of the femur.

Over-riding is a common form of displacement and may be associated with one of the other varieties.

The actions of the muscles have a marked influence upon the over-riding of the fragments. If the force of the injury continues after the bone is broken the over-riding will be quite pronounced (Fig. 81).

Impaction occurs frequently in spongy portions of the bones and is caused by the force of the injury driv-

ing the harder and usually smaller—but not necessarily shorter—fragments into the soft spongy portion of the bone (Fig. 77.)

Longitudinal separation is usually caused by the contraction of the muscles and the best examples of this variety are found in the fracture of the patella, the olecranon, and coronoid processes of the ulna.

**Etiology.**—PREDISPOSING CAUSES. Nature has well arranged the bones making up the skeleton to protect important organs, but in so doing many bones are predisposed to fracture on account of the positions which they occupy in the body. Fractures take place at any period of life, and neither the young nor the old are exempt.

The reason why the greater number of fractures occur in men during middle life (excepting the partial or bending varieties of children and the fractures occurring in old age) is on account of the occupations men follow. In old age the fragility of the bones is due to an actual decrease of lime matter and not simply to an alteration in the proportion of the lime and earthy materials. Other predisposing causes may be syphilis, cancer, and undoubtedly any disease characterized by a cachexia. Syphilis, more frequently than is ordinarily supposed, is a predisposing cause of fracture. In many cases where attempts have been made to introduce metallic sutures into the fractured ends of bones, operative measures have had to be abandoned, because the bones were found to be syphilitic.



Fig. 81.  
Fracture Showing  
Over-riding.



Fig. 80.  
Author's Case, Showing Angularity, Rotation and Over-riding.

**EXCITING CAUSES.** External violence and muscular contraction are the exciting causes of fracture. *External violence* may be divided into two forms, direct and indirect. Bones break at the point of least resistance, either directly at the seat of injury (direct violence), or at a distance from the seat of injury, (indirect violence).

In certain cases the foot is firmly wedged and held as in a vise, and the weight of the body, moving in a direction forward or backward, will fracture the leg far away from the point of fixation.

*Muscular Contraction.* In fracture of the patella, which in almost every case is produced by muscular contraction alone, the skin overlying the knee is often found bruised. The knee strikes the ground after the fracture has taken place, and the injury to the skin is produced by external violence after the rupture of the bone occurs. Many of the other bones are frequently fractured by muscular contraction, the humerus, the clavicle and the tibia furnishing the principal examples. The humerus is often broken by the simple effort of throwing a stone. The clavicle may be fractured by some quick, unusual motion of the arm, as the raising of a window. Fractures by muscular contraction are ordinarily transverse, and are unaccompanied with shortening. In the patella and olecranon actual separation occurs. Crepitus is usually readily detected, especially in fractures of the humerus. The humerus when fractured by muscular contraction is usually broken in its middle third. This accident occurs to ball players.

Intra-uterine fractures are due to direct violence, produced either by the accoucheur or by the contractions of the uterus.

**Symptoms and Diagnosis.**—It is important to differentiate between fractures, contusions and dislocations. From the very beginning of the examination in any case a complete history of any injuries previously received should be obtained from the patient in order that any old deformity may not be confounded with a recent injury.

DEFORMITY is a common sign of fracture and when present aids materially in establishing a diagnosis. In impacted fractures little deformity exists.

Although the action of certain groups of muscles materially influences the deformity in many fractures, still this action or contraction does not play the important part accredited to it by older writers, and the deformity in many cases is caused by the force of the injury. Many of the cuts are introduced in this chapter to show some of the frequent forms of fracture, rather than the effects of certain muscles upon the position of the fractured ends of the bones.

ABNORMAL MOBILITY. This is a valuable symptom in making a diagnosis in fracture, and is constantly found in every case unless the fracture is of that variety known as "impacted." The normal motion of neighboring joints in many cases of fracture is difficult to distinguish from the abnormal mobility at the seat of fracture.

CREPITUS. When crepitus is present it is pathognomonic of fracture. It is occasioned by the fractured surfaces of the bones rubbing together, but in many instances it cannot be obtained because the broken ends of the bones are actually separated. In other cases portions of soft tissue are forced between the fractured surfaces of the bones.

LOSS OF FUNCTION, or limited function, of near-by joints is observed in most cases of fracture. This impaired function depends upon the severity of the injury, the joint involved, and the bone or bones fractured.

PAIN, SWELLING AND ECCHYMOsis are symptoms which accompany nearly every form of injury, but in themselves are of little value as diagnostic signs of fracture. Pain, from pressure and motion, is always



greatest directly over the line of separation of the fractured ends of the bone. Swelling appears early in fractures and is very great in those which involve the joints. Ecchymosis is not noticeable during the first few hours, or even days, of the treatment. It extends in any direction and covers large areas and is very noticeable after the second or third dressing.

The tendency of the deformity to constantly recur after reduction distinguishes this injury from a dislocation, and it is always noticeable in the shafts of the long bones and when both bones of the leg or forearm are fractured.

#### Examination of Patient.

—Great gentleness should be observed in manner and speech during the examination of these patients. Fear of pain will often cause violent contraction of the muscles, which will act as an obstacle to reduction, and the surgeon should reassure the patient that he will not suffer great pain.

**Repair of Broken Bones.**—When a fracture occurs in any bone plastic lymph is thrown out not only from the haversian canals but from the adjacent soft tissue, including the periosteum. The broken ends of the bone unite directly with one another, as soft structures do, or granulations springing from the bone ends and the periosteum join and pass by successive steps into bony material.

Compound fractures are repaired by the transition of granulation tissue, first into connective tissue and finally into osseous material. The amount of callus found in fractures varies. Defective immobilization is a cause of exuberant callus.

The length of time required for bones to unite varies according to the variety of the fracture, the age and general condition of the patient.

In children union takes place rapidly, and in a few instances the lymph thrown out at the time of the injury is transformed into cartilaginous tissue before the osseous material appears. This never occurs in adults, but connective tissue takes



Fig. 82.

Fracture of Rib with Emphysema.—Bishop.

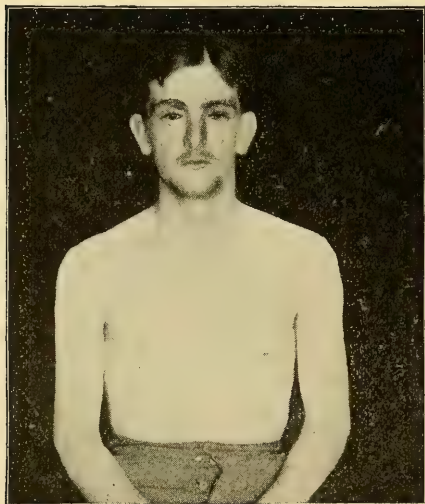


Fig. 83.

Author's Case After Reduction of Emphysema.



the place of the cartilaginous. Four to twelve weeks is the time required for the repair of fractures.

**Prognosis.**—The complications which often accompany fractures are frequently more serious than the fractures themselves. Important nerve trunks or blood vessels may be pressed upon or even severed. Portions of the viscera may be injured. Puncture of the pleura and lungs frequently occurs when one or more ribs are fractured. Figs. 82 and 83 are from photographs taken of a case where extensive surgical emphysema followed an injury to the bony framework of the chest, a fracture of one of the ribs. Paralysis of groups of muscles is frequently a sequence of fracture. Limited function of joints involved in fractures, tenderness of the leg or arm, and pain from excessive callus may be anticipated after fractures. Shock carries off many patients, and if death does not take place from this cause, some degree of shock will always be noticed, especially in fractures of the “small part of the neck of the femur.”

The swelling which appears after the dressings are finally removed may be very great and may last for weeks and months. Pain with the weather-changes may exist for years or even throughout life.

Embolism, gangrene, tetanus, septicemia have all been observed as complications of fractures. After fractures delirium tremens develops in many patients who are addicted to the use of stimulants, and the alcohol should not be withdrawn suddenly from these patients. Violent attacks are frequently averted by the administration of large doses of whiskey.

**Ankylosis.**—When joint surfaces are traversed by the line of separation of a fracture the chance of permanent or partial stiffness of the joint may be expected. The apprehension that ankylosis may be permanent after fractures involving, or near, joints has been the cause of much meddlesome surgery. Bony deposit cannot occur in a joint when simply placed at rest, that is when inflammation is absent and the cancellous structure of the bone ends is not opened. Passive motion will not prevent stiffness of a joint, but it will prevent adhesions of the tendons near the seat of injury, or even “ossification” of the tendons. Displaced fragments and stalactitic formations in a joint may cause ankylosis. When any region of the body is involved in inflammation the one object sought for in the treatment is rest, and the joints, above all other structures of the body, should be kept quiet. Immobilization is the greatest factor in the treatment of fractures, and to keep the divided ends of the bone in apposition and at the same time to practice daily passive motion of the neighboring joint is an impossibility. To be sure, by the omission of passive motion some stiffness of the joints is noticeable when the fracture dressings are first removed, but in a few days or weeks this stiffness disappears. If a person is not able to obtain good use of the limb it will be an easy matter for the surgeon to start the improvement by forcibly breaking up the adhesions. This procedure is free from danger provided the ankylosis is of a fibrous and not of a bony nature.

The surgeon to-day unhesitatingly immobilizes any articulation of the body and does not fear ankylosis when he places a joint at rest during the weeks of treatment of fractures. Small joints are more liable to ankylosis than large ones. If physicians and surgeons would pay more attention to the proper reduction of the fracture and the maintenance

of the broken ends of bones in their proper places, have less fear of stiff joints, and would avoid passive motion the percentage of perfect cures would be greatly increased.

**Cellulitis.**—Severe cellulitis frequently causes the surgeon endless trouble and anxiety, and in many instances amputation has finally been necessary. Figure 84 shows the case of a boy who sustained a fracture in the middle third of the humerus and the complications which followed nearly destroyed his arm. The multiple punctures which show in the cut as small black points afforded an exit to the pus which formed subsequent to the injury.



Fig. 84  
Cellulitis After Fracture.

**Compound Fractures.**—The prognosis should be very guarded in all cases of compound fractures, and many of the limbs, although deformed, which are now saved since the introduction of antiseptic measures, are triumphs to surgery. In a compound fracture where the soft tissues have been pierced by the sharp ends of the fragments the prognosis, of

course, is more favorable than where the injury has been produced from without, since little chance of the introduction of foreign material into the wound has occurred.

**Medication.**—Remedies may be required in various complications attending upon fractures, especially conditions like cellulitis and general inflammatory processes, and medication may also be advantageous in compound fractures where unhealthy states of the soft tissues follow. The reactionary fever of bone injuries may require aconite, belladonna or gelsemium, and since this is often seen even in fractures that are not compounded or complicated, these and other remedies may be called for during the first day or two in nearly every case. If cellulitis sets up apsis, arnica and arsenicum will meet the requirements as a rule. If an erysipelas-like appearance ensues belladonna or rhus may be needed. Symphytum has a specific effect upon bony tissue and will be found helpful in allaying pain in fractured bones, while silicia and calcarea will be prescribed if union is delayed or unsatisfactory. Here calcarea phosphorica, especially in children, is also a valuable agent.

## CHAPTER II.

### GENERAL TREATMENT OF FRACTURES.

---

**Patient's Bed.**—In the selection of a bed for the use of fracture cases care should be taken to have one which is narrow and high. The mattress should be firm and made of hair. All fracture beds which have been suggested, although many of them are ingenious, do not possess any advantage over the ordinary iron bedsteads. The “Gorham” bed, very perfect in its workmanship and undoubtedly suitable for chronic invalids, does not possess any special features which recommend it as a fracture bed.

**Reduction.**—Great care must be exercised in the removal of the patient's clothes, and in transferring him from the place where he has received the injury to his home, or from the place of his examination to the bed. When broken limbs are roughly handled a vast amount of injury to important structures beneath the skin surface is produced.

The time for the reduction of a fracture will be regulated by the character of the injury and the condition of the patient. It is always well to place the ends of a broken bone in apposition early, but it is not absolutely necessary to do this in those cases where the swelling is very excessive. Damage to vessels and nerves has been repeatedly caused by violent attempts to reduce fractures during the period of swelling. It is far better to place the leg either in a fracture-box (Fig. 85) or in a soft pillow (Fig. 86) and wait until the swelling subsides before attempting reduction.

In order to reduce many fractures it is necessary to use an anesthetic, but great caution must be observed in its use, as cases frequently occur where permanent injury to the underlying soft tissues of unconscious patients has been produced.

The use of fomentations to recent fractures should be discouraged, as the softening of the skin produced by these moist applications will usually be the beginning of serious trouble and may possibly cause many fractures which are simple and uncomplicated in the beginning to change into the compound or complicated variety later on.

After a fractured limb has been examined and the deformity has been partially or completely overcome by moderate traction the limb should be placed at rest in a dressing which approaches as nearly as possible to a permanent dressing.

**Temporary Dressings.**—In many injuries, especially fractures of the leg, where extensive laceration of the soft parts has occurred, temporary dressing will have to be employed for a short period. This temporary dressing may be made of a soft pillow, which is folded round

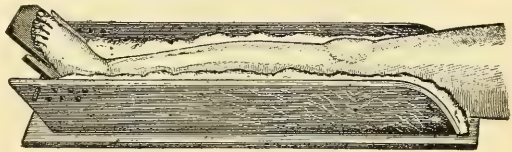


Fig. 85.  
Fracture Box.



the leg and tied in three places by strips of muslin (Fig. 86.) Fracture boxes (Fig. 85) are useful in a few cases, and felt splints and perforated tin splints are sometimes used. The temporary dressing should be discarded at the earliest possible moment for the permanent dressing.

**Permanent Dressings.**—Many forms of inflexible and semi-inflexible dressings have been devised and suggested for every fracture of the

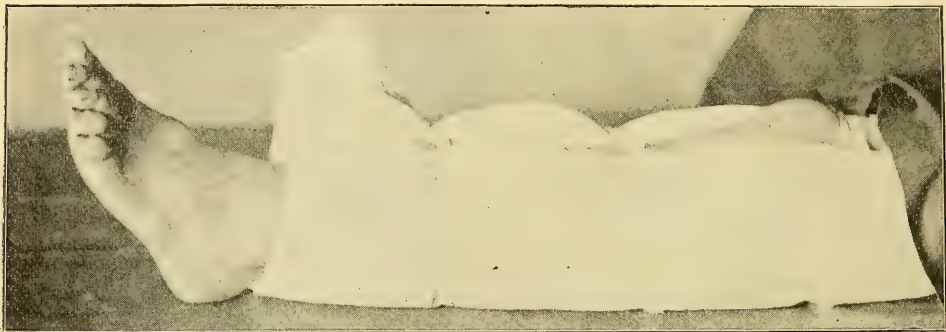


Fig. 86. Pillow Dressing.

body. At the present time all carved wooden and metallic splints have been discarded. The perforated metallic splint for Colles' fracture suggested by Levis is still in use, but this is the only splint, out of the many tried, which is of any value. Moulded splints, of felt and plaster of Paris, are easily made to suit all the conditions necessary for the proper treatment of every fracture.

**ADHESIVE PLASTER.** This material is depended upon for certain dressings;—namely, “Sayre’s dressing for fractured clavicle” and the extension used in “Buck’s modified dressing” for fracture of the thigh. Straight wooden splints (inflexible) are used for dressings where lateral support is required; and for all fractures of the forearm they are indispensable. The roller bandage used in fracture-dressings is made of unbleached muslin, and varies in length and width according to the variety of the fracture treated. All splints are well padded, especially over projecting bony prominences.

**FRACTURE-BOXES.** These are at times useful, but only as temporary dressings. Moulded splints made of plaster of Paris have taken the place of the old fracture-box. These splints may be so constructed that they may be suspended from the bed by inserting into the anterior surface of the splint metal bars (Fig. 87.)

**PERFORATED METALLIC SPLINTS.** While these are better than the old carved splints of wood perforated metallic splints possess no advantage over splints made of plaster of Paris. They are expensive and cumbersome and, in many cases, harm will follow their use. This, however, is true of all splints.

**FELT OR GUM-SHELLAC.** Moulded splints made of either of these

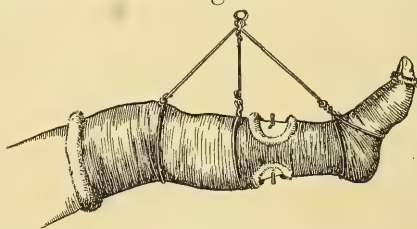


Fig. 87.  
Plaster of Paris Splint with Windows for Drainage.

materials are in extensive use. They may be temporarily softened by placing them in hot water and moulded so as to fit any limb.

**PLASTER OF PARIS SPLINTS.** Moulded splints of plaster of Paris are in general use; and while plaster of Paris is the best material which we have at our command for fracture dressings it is at the same time the most dangerous in unskillful hands. This dressing has been the cause of many deformed limbs, stiff joints, and the cause of many amputations for gangrene. In not a few cases the lives of patients have been sacrificed either by death from exhaustion from the inflexible incasement of their bodies in plaster of Paris or from the complications which have arisen from the use of this inflexible material.

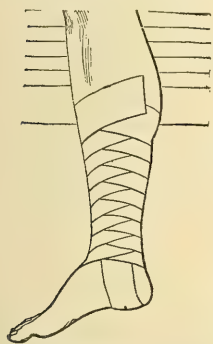


Fig. 88.

Bandage of Scultetus.

The surgeon who entrusts the application of plaster of Paris splints to an inexperienced assistant certainly is directly responsible for any bad results which may follow its use, because no man who has dealt with this substance extensively can fail to appreciate its danger when used as a fracture-dressing.

**MOULDED SPLINTS OF PLASTER OF PARIS.** Crinoline is the material with which to incorporate the plaster of Paris for these splints. A pattern of the leg or arm is made and the crinoline, which is arranged in layers (from six to twelve), plaster of Paris having been incorporated between the several layers, is shaped to this pattern. The bandage is then placed in tepid water, not too warm and not too cold, and after the bubbles of air have ceased to rise to the surface of the water the bandage is removed from the vessel and gently squeezed. It is then adapted to the injured limb, and is held in position either by means of the hands or a light gauze roller until it is thoroughly dry. It is then removed, carefully padded with cotton and reapplied to the limb, and held there by a roller bandage. The bandage of Scultetus (Fig. 88) is preferred by Doughty for holding this dressing in place.

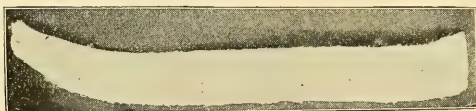


Fig. 89.

a. Keen's Splint—Anterior.



Fig. 90.

b. Keen's Splint—Posterior.

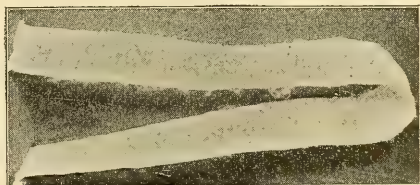


Fig. 91.

c. Keen's Splint—"U" Shaped.

Non-absorbent cotton should be used in preference to the absorbent variety for all fracture-dressings.

**SPLINTS MADE OF PLASTER OF PARIS BANDAGES.** The limb is shaved and a thin layer of cotton placed over it. Bandages made of crinoline and pure dental plaster are now rolled on the limb, care being taken that the bandage be not drawn tightly. The bandage should be rolled around the limb more by its own weight than by actual tension on

the surgeon's part; and all reverses and complicated turns should be avoided; the bandage should simply pass circularly around the limb.

**STEEL FRAMES.** Frames or bands of iron or steel, when suspension is desired, are incorporated in the dressing while the plaster is hardening.

**KEEN'S PLASTER OF PARIS SPLINT.** To Keen, of Philadelphia, belongs the credit of suggesting the use of a dressing made in three distinct divisions. will be described on page 464 and may fractures of one or both bones of the leg. degree of extension is obtained when the (Fig. 89) is strengthened by a

**THE EXTENSION DRESSINGS.**  
Introduction into surgical practice  
for the treatment of fractures

plaster of Paris  
This dressing  
be applied to  
Some slight  
anterior splint  
piece of tin.  
Since the in-  
of extension  
the results

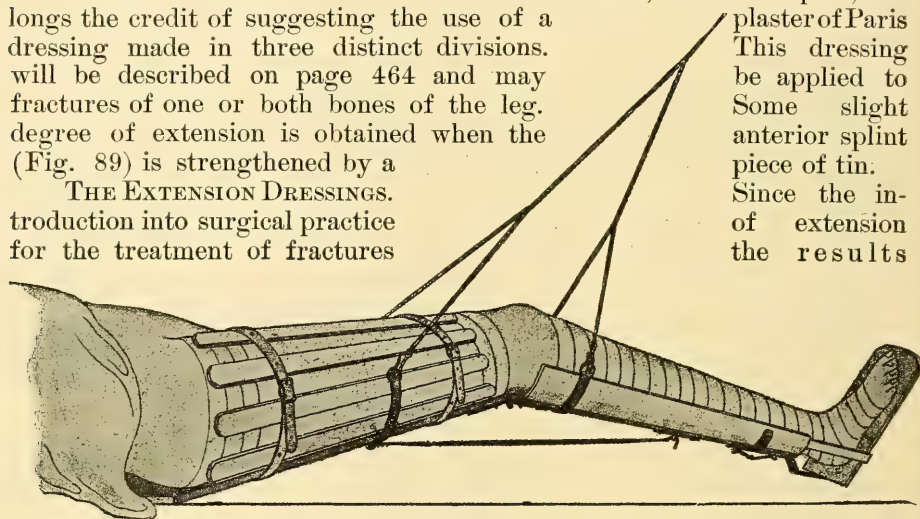


Fig. 92.

**Morgan's Fracture Splint—Affording Continuous Extension and Compression.**

have been marvelous. The many forms of inclined planes and Smith's anterior wire (Fig. 94) and Hodgen's splint (Fig 93) have all given way to the use of an apparatus known as "Buck's Modified Extension," combined with a long side splint. (Fig. 95). When Buck's extension was first introduced a perineal band constituted a part of the dressing. It was soon proved that this perineal band could not be tolerated during the tedious weeks of confinement in bed and that it was un-

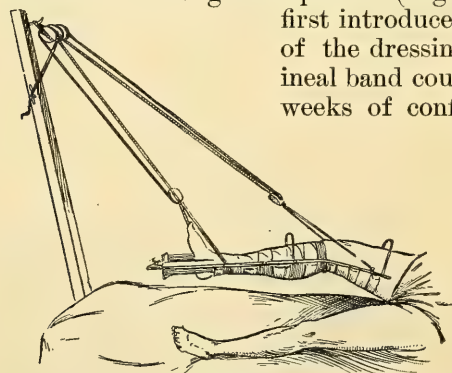


Fig. 93.  
Hodgen's Splint.

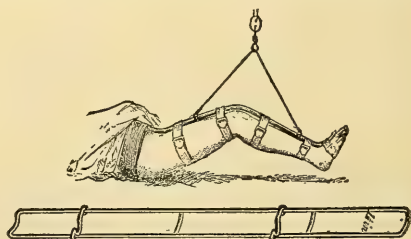


Fig. 94.  
Smith's Anterior Wire Splint.

necessary. Counter-extension can be permanently and comfortably made by elevating the foot of the bed six or eight inches.

**BUCK'S MODIFIED EXTENSION.** This is the method (Fig. 95) which is used in treating all fractures of the femur from a "Supra-condyloid" to a fracture at the "Small part of the Neck." A small block of wood a quarter of an inch thick, five inches in length and three inches in width, perforated in the centre, is used for attachment to the adhesive plaster and is known as the "foot-piece" (Fig. 96). In every case this foot-piece



should be long enough so that the plaster will not impinge upon either malleolus. A strip of adhesive plaster about eight inches wide and about four feet long is selected, and in the centre of this plaster is placed the "foot-piece," its long diameter being parallel with that of the adhesive plaster. The plaster is then to be cut into four tails (see Fig. 96) but the

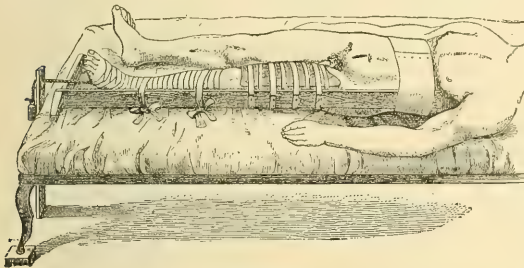


Fig. 95.

**Buck's Extension and Long Side Splint Applied.**

muslin covering the plaster is not stripped off from the lower end of the extension to a point just above the malleoli. The distance from the malleoli to the foot-piece should be about nine or ten inches, this long draft being more satisfactory in all cases. When the distance from the foot-piece to the malleoli is of this extent the foot-piece does not interfere with the lower end of the long side splint recommended for treatment of fractures of the thigh. The leg should be shaved before the plaster is applied, and the plaster should be covered by a gauze roller very loosely applied. The cord attached to the foot-piece passes down to the foot and over a pulley which is fixed in a "standard" (Figs. 97 and 98.)

The weight required will vary from ten to twenty-five pounds, according to action of the muscles and the age of the patient. All fractures should be inspected often, and during the first days of treatment should be examined daily.

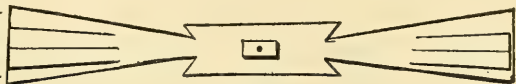


Fig. 96.  
Foot-Piece.

#### **Ambulant Treatment for Fractures of Leg and Thigh.—**

Contrary to all the principles of the treatment of fractures, the German surgeons have suggested a new plan whereby the tonicity of the muscles and the general health of the patient do not suffer during the long period of the treatment of fractures.

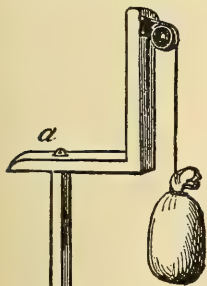


Fig. 97,  
Standard.

Elbogen, of Prague, has treated many cases by this method and many of the German authorities have spoken on the subject; however, this treatment has not become a recognized method of procedure in American institutions.

The treatment consists in allowing the patient to walk about within a few hours or days after the receipt of the injury by the employment of an apparatus which supports the limb in its natural position.

The knee is slightly bent, as is also the foot (dorsally flexed) and the entire limb is encased in plaster of Paris, the patient walking on his toes. The deformity must first be reduced and it is better to wait a few days until after the swelling has begun to subside before applying the dressing.

The advocates of this method allow their patients to try to walk

The advocates of this method allow their patients to try to walk

with the aid of crutches, of course, after first applying the plaster of Paris splint, within a few hours of the receipt of the injury; and in a day or two, or at the most at the end of a week, they allow them to walk without any support in the shape of canes or crutches. To the author's mind this method is open to many objections and the few points of advantage claimed for it, as shortening the length of time of confinement, maintenance of perfect health in the aged, the prevention of atrophy of the muscles, are more than balanced by the dangers which are likely to follow from this injudicious use of plaster of Paris to newly fractured limbs.

This treatment can only be carried out with safety in hospital practice, where the application of this dressing can be superintended and watched by those familiar with its dangers.

When the line of fracture is transverse this method may be used, but where the fracture is oblique and much shortening is present the value of extension should not be overlooked, and it would not be a justifiable procedure for any physician to adopt this treatment. No doubt many cases of "delirium tremens" have been prevented by this treatment in patients (alcoholics) who have sustained fractures, but it would be very unwise and unsafe to advise students to adopt this method before it has been recognized and approved by the leading surgeons of the world.

**Treatment of Compound Fractures.**—Foreign substances should be picked out of the wound, which should be thoroughly disinfected by antiseptic solutions. The sharp ends of the fragment should be removed by means of bone forceps, and perfect drainage, either by means of a drainage tube or strips of iodoform gauze, should be secured. The fracture should be converted as rapidly as possible into a simple one and during the period while the wound is healing the fracture dressing should be such as will secure perfect immobilization, and at the same time allow the surgeon access to the seat of injury, so that the wound may be dressed. Metallic sutures or ivory pegs should not be employed when it is possible to avoid their use. Kangaroo tendon is the best material for sutures when it is necessary to employ them, but oftentimes the periosteum may be stitched instead of introducing the sutures directly through the ends of the bone. When the wound is on the upper surface of the limb and the pus burrows between the deeper structures over-lying the bone a counter-opening will oftentimes have to be made (Fig. 99.)

When these cases are first seen they should be subjected to the following treatment: The leg is scrubbed with an antiseptic soap solution, shaved and the wound thoroughly irrigated with bichloride of mercury 1-2000. Drainage is then provided for either by a tube or iodoform gauze. The wound is then covered with sterilized gauze and the entire member encased in a plaster of Paris dressing. When possible this first dressing should not be disturbed for four or five days. In many cases it is practicable to carry out this treatment, omitting the application of the

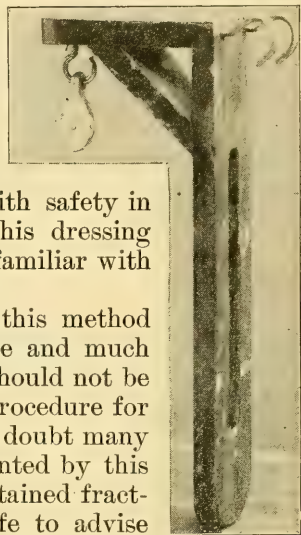


Fig. 98.  
Holden's standard for extension. The two hooks on back of frame grasp the iron rail on foot of bedstead.



plaster at the place of injury. This method should be adopted by ambulance surgeons because many cases of compound fracture may be saved from amputation by this thorough and early treatment.

When joints are involved resection will often be necessary, as in many cases limbs with false joints, after resection, are more useful than deformed limbs, stiff joints resulting from careful and intelligent treatment without resection. Amputation is rarely required and is resorted to only after patient and prolonged treatment fails.



Fig. 99.  
Counter Opening  
for Drainage.

**Treatment of Delayed Union, Fibrous Union, and Non-Union.**—When abnormal mobility at the seat of fracture continues after the period ordinarily specified for the treatment of any special fracture the case is known as one of delayed union. Delayed union is common, while non-union is rare. It is difficult to determine the exact time when a case should be transferred from a variety known as delayed union to that of non-union, because in many instances where delayed union is noticed good, firm, bony union takes place later.

Cases of delayed union may suddenly change and good union occur even after one year.

**CAUSE.** Imperfect immobilization, syphilis, pregnancy and scurvy are frequent causes. In alcoholics, especially when the stimulant is withdrawn after the injury is received, delayed union is quite common. Age has but little effect, but many local causes, such as tight bandaging, or the interposition between the fractured ends of a piece of tendon or capsule are frequent causes of delayed union.

**VARIETIES.** The fractured ends of a bone are partially connected by a fibrous material, which is never converted into new bone, or no attempt at union at all takes place.

**CONSTITUTIONAL MEASURES.** The general health of the patient should be carefully watched and improved. If he has been confined to the house for a long period he should be so placed that he will obtain a direct change from in-door to out-door life. If a constitutional disease, such as syphilis, is present he should have the proper constitutional treatment. It is the writer's experience in dealing with syphilitics that union has always been prompt and perfect when the constitutional disease has been treated by constitutional remedies during the period of the treatment of the fractures.

**MECHANICAL TREATMENT.** If immobilization has been imperfectly carried out inflexible splints should be employed, preventing, even in the slightest degree, any motion at the seat of fracture.

If immobilization has been perfect through all the weeks of treatment it is advisable to forcibly rub the fractured ends of the bone together and replace the limb in the original dressing. If, after a few weeks, this is found to be of no avail, the sub-cutaneous puncture may be made. This operation consists in passing the point of a needle or a small drill down between the ends of the divided bone and freely irritating the



fractured surfaces. Under strict aseptic precautions no harm ever results from this procedure. One exception is made to this rule—that is, in the case of the shaft of the femur, where it has been found that this method has caused disastrous results. In many cases it is far better to cut down upon the seat of fracture and, by means of a saw, cut off the ends of the bone. All fibrous, partly-organized material is cut away, and the wound treated as any ordinary compound fracture. It is in many cases not required to resort to these extreme measures, as it is only necessary to encourage the patient to use the injured arm or leg in order to bring about repair.



**Fig. 100.**  
**Vicious Union.**

**Vicious Union.**—This occurs in many cases where the patient has received unskilled treatment or where defective apparatus has been used. (Fig. 100). Extreme deformity may result, pressure upon important nerves causing pain or paralysis may be present, or shortening results where extension has been neglected.

### CHAPTER III.

## FRACTURES OF HAND AND FORE-ARM.

**Fracture of the Phalanges.**—**CAUSE.** The phalanges are broken by direct force. This injury frequently occurs in ball playing.

**PATHOLOGY.** The line of separation is usually transverse, but in some cases it is oblique.

**SYMPTOMS.** Deformity, crepitus, swelling, pain and abnormal mobility are the prominent symptoms.

**PROGNOSIS.** Union takes place rapidly, but deformity is likely to remain. Amputation may be necessary, but many badly injured fingers are saved by careful treatment.

**TREATMENT.** Moulded splints, made of gutta percha or card-board, felt, tin, or plaster of Paris are used. The finger should be kept constantly in a semi-flexed position.

**Fracture of the Metacarpal Bones.**—**CAUSES.** The metacarpal bones are frequently fractured during fights or by direct violence of a crushing nature.

**PATHOLOGY.** The line of fracture is usually oblique, and when the ring finger is the one injured the action of the adductor brevis pollicis muscle often draws the upper fragment toward the thumb.

**SYMPTOMS.** Crepitus may usually be elicited. Swelling comes on early. Few other symptoms are present. Deformity is not marked.

**PROGNOSIS.** Union occurs in four weeks.

**TREATMENT.** Anterior and posterior straight splints are applied to the entire back and palm of the hand. A roller bandage placed in the palm of the hand, flexing the fingers on it, will very often be useful.

**Fracture of the Carpal Bones.**—This fracture is rare and is often complicated with extensive laceration of the soft parts. It is frequently compound.

**CAUSE.** Direct injury of great force.

**PATHOLOGY.** The fracture is at times comminuted and compounded, and small, loose pieces of bone are seen in the wound.

**PROGNOSIS.** Ankylosis or some loss of power of the wrist is always likely to follow.

**TREATMENT.** Immobilization of the hand

and wrist is best carried out by anterior and posterior straight splints.

**Fracture of the Coranoid Process of the Radius.**—This fracture is rare unless accompanied with a dislocation of both bones of the fore-arm backward. (Fig. 101.)

**CAUSE.** Blows received over the process, and falls upon the hand produce this fracture.

**PATHOLOGY.** The coranoid process moves about as a loose body in the joint and this fracture is usually accompanied with a dislocation of both bones of the fore-arm backward.

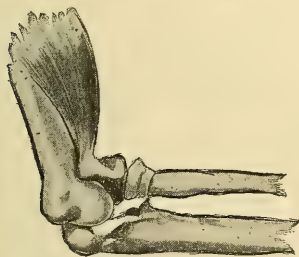


Fig. 101.  
Fracture of the Coranoid  
Process.

**SYMPTOMS.** Crepitus is felt when efforts at flexion or extension are made. Abnormal lateral motion of the joint is a prominent symptom. The arm is usually held in a flexed condition and on account of the loose coronoid process the elbow cannot be flexed beyond a right angle.

**PROGNOSIS.** Union is often fibrous and takes place with some deformity or with the formation of exuberant callus, which materially interferes with full extension, flexion, supination or pronation of the hand.

**TREATMENT.** The flexed position of the arm at the elbow is the proper one. Moulded splints, either of felt or of plaster of Paris, are used.



Fig. 102. Fracture of Upper End of Radius.

**Fracture of Upper End of Radius Above Tubercle.**—This division includes fracture of the head which is infrequent, and fracture of the neck, which is also rare.

**CAUSE.** Direct force applied over the head of the bone or forcible extension from the wrist is the cause.

**PATHOLOGY.** The lower end of the bone is found displaced forward by the action of the biceps muscle (Fig. 102.)

**SYMPTOMS.** Crepitus, a movable body felt in the bend of the elbow, and a locked joint are the common symptoms. This injury may be mistaken for a dislocation of the head of the radius forward.

**PROGNOSIS.** The union may be fibrous, the head of the bone may become necrosed, or the callus may act as an obstacle to the free motion of the joint. Ankylosis frequently follows this injury.

**TREATMENT.** Some surgeons advise, of late, cutting down at once and removing the head of the bone. The flexed position undoubtedly should be employed throughout the treatment, because the action of the

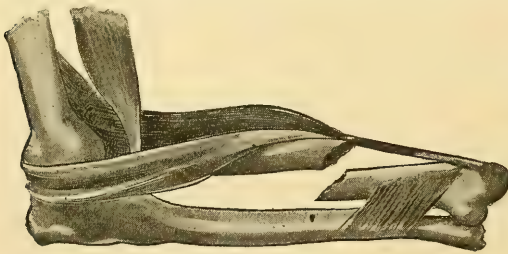


Fig. 103. Fracture of Radius.

biceps muscle will be sufficient to keep the fragments separated by elevating the lower fragment. The arm should be kept midway between supination and pronation, or, better, if the patient can stand it, in complete supination.

**Shaft of the Radius.**—

This injury is usually accompanied by the fracture of the

ulna. It may occur at any point of the shaft.

**CAUSE.** It is produced by direct force, usually of a crushing nature (machinery accidents). Both bones of the fore-arm are usually broken when the arm is caught in fly wheels, but cases constantly occur in which only one bone is fractured from this cause.

**PATHOLOGY.** The line of fracture is usually oblique (Fig. 103.) It takes place at any point, from the insertion of the pronator radii teres muscle to the insertion of the biceps.



**SYMPTOMS.** The deformity is more or less marked, and is caused by the action of the unopposed muscles; marked inability to pronate the hand is a prominent symptom. The circumference of the forearm is increased at the seat of the injury and pain, swelling and loss of function are always present.

**PROGNOSIS.** Good bony union occurs, but some loss of supination and pronation follows. Union may take place between the fractured surfaces of the bones while the upper fragment is in supination and the lower one in pronation. An inter-osseous bridge may form between the bones of the fore-arm at the seat of injury (Fig. 104.)

**TREATMENT.** The elbow must be flexed and the forearm carried across the body, and the dressing composed of anterior and posterior straight splints (Figs. 107 and 108) for fractures of the shafts of the ulna or both bones of the fore-arm, should invariably be employed. This dressing should always immobilize the wrist. Treatment is carried out for five weeks.

**Fracture of the Lower End of the Radius—Colles' Fracture.**—This fracture occurs about once out of every dozen cases of fracture. By Colles' fracture is meant fracture of the lower end of the radius from a fraction of an inch to an inch and one half from the styloid process, accompanied with a dislocation of the ulna, from the inter-articular cartilage.

**CAUSE.** It is almost invariably caused by falls upon the palms of the hand. Both radii may sometimes be fractured by falling from heights or into holes, the patient pitching head foremost, with his hands out-stretched.

**PATHOLOGY.** The line of separation occurs at the lower end of the radius and, at most, not more than one and one-half inches from the end. The lower fragment is displaced backward, over-riding the lower end of the upper fragment. There is usually some degree of lateral dislocation. That is, the hand is deflected to the radial side because of the dislocation of the ulna from the inter-articular cartilage.

**SYMPTOMS.** Crepitus is difficult to make out until after the fracture has been reduced, but the so-called silver fork deformity is characteristic. The hand falls toward the radial side and the styloid process of the ulna is very prominent. Swelling, pain, abnormal

mobility, and loss of function are always present (Figs. 105 and 106.)

**PROGNOSIS.** Deformity following a fracture of the lower end of the radius is frequently noticed, but in the majority of the cases it is due to defective treatment at the time of the receipt of the injury rather than to improper splints employed. The permanent deflection of the hand to the radial side may be anticipated, as this deformity may exist in some



Fig. 104.  
Formation  
of Inter-os-  
seous Bridge.



Fig. 105. Radial Fracture.—Bishop.

degree even after the most careful and intelligent treatment. Swelling is very great and the pain is intense. Union is generally prompt and non-union is rare, but if the deformity escapes recognition and the fracture is not reduced the union will be vicious or fibrous and the usefulness of the hand impaired or destroyed.



Fig. 106.

Fracture reduced by author three weeks after receipt of the injury.

TREATMENT. The reduction should be accomplished early, and is made by the surgeon grasping the hand while it is pronated and making hyper-extension and traction while an assistant, by means of his thumbs, presses down on the lower fragment. Traction is now kept up while the hand is brought rapidly into forced flexion. Repeated attempts may be made, and if unsuccessful a rocking or lateral movement should be combined with the above manipulations. Many dressings and splints have been devised and suggested for this injury, but experience has shown that a dressing composed of an anterior and a posterior straight splint, applied after the following manner, is the most satisfactory of all dressings (Fig. 107.)

*Description of Dressing.* (Anterior and posterior straight splints). Two inflexible straight splints are obtained, both wide enough so that after the bandage is applied laterally constriction of the fore-arm by the bandage is impossible. The anterior splint is longer than the posterior and extends from the palm of the hand to a point just below the bend of the elbow. The posterior splint extends from the phalango-metacarpal joint to the elbow. These splints are wider at their upper than at their lower ends, and both are well padded. Two small pads, one placed over the upper end of the lower fragment and the other over the lower end of the upper fragment, are often required in this dressing. While the splints are held in place the arm is flexed at the elbow to a right angle, and is held midway between supination and pronation. Two narrow strips of adhesive plaster are placed around the splints and arm at either end of these two splints, which thus keep them parallel. A



Fig. 107.

Anterior-Posterior Straight Splints Applied.

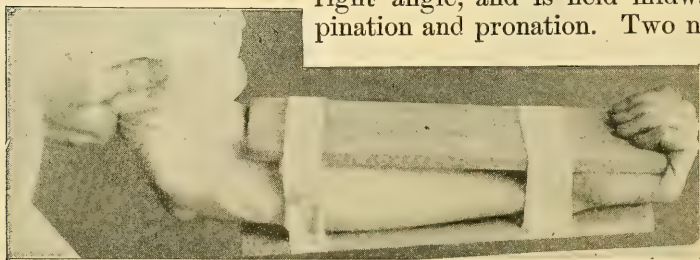


Fig. 108. Splints showing adhesive straps applied in the anterior and posterior straight splint dressing for Colles' fracture.

roller bandage is now applied, leaving the thumb and fingers uncovered, and the fore-arm is placed in an arm-sling and retained in a position midway between supination and pronation. Care should be taken that the upper end of the anterior splint does not make pressure in the bend



of the elbow. The patient is directed to keep his thumb turned out. This dressing should be constantly inspected and the adhesive straps and roller tightened as the swelling subsides. The treatment is continued for five weeks.

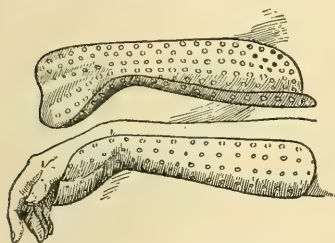


Fig. 109. Levis' Splint.

superior to those obtained by any of the patent splints.

**Fracture of the Olecranon Process of the Ulna.** — CAUSE. This injury occurs frequently and it is occasioned by falls upon the elbow or direct violence applied to the elbow. A few cases caused by muscular contraction have been reported.

**PATHOLOGY.** The line of fracture is oblique or transverse, and the fracture occurs at any part of the process. The periosteum is not always torn and only slight separation of the fragments occurs in these cases. However, the separation may be as great as two inches in other cases. (Fig. 113.)



Fig. 110. Bond's Splint.

**SYMPTOMS.** The movable process at the bend of the elbow is easily detected, especially when the arm is flexed. Crepitus is absent because the process is drawn upward by the triceps muscle. Some pain is experienced over the line of fracture when attempts at flexion are made. No serious loss of function of the elbow is ever observed.

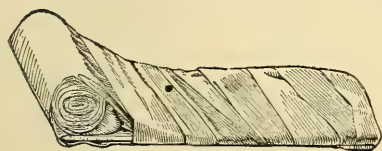


Fig. 111. Hays' Splint.

**PROGNOSIS.** Union is usually fibrous. This fibrous band may be one inch broad and still the usefulness of the elbow will not be impaired. Many of the bad results obtained in this fracture are occasioned by faulty treatment. When this injury is treated with the arm in an extended position the danger of ankylosis is slight, and even if it does occur it is a simple matter to break it up at the end of the treatment.

**TREATMENT.** Hamilton's splint gives very satisfactory results. (Fig. 114.) A thin, light board, long enough to reach from below the axilla to the wrist, is applied to the anterior surface of the arm and by means of bands of adhesive straps or, preferably, turns of a roller bandage, the olecranon process is held in fairly close apposition to the shaft of the ulna. The splint is secured to the arm at either end by a few turns of a roller bandage. This dressing should be changed often, and these oblique turns, passing

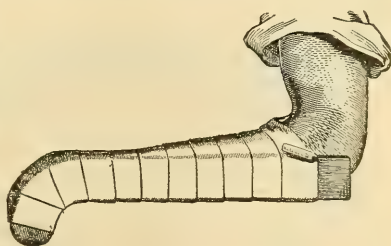


Fig. 112. Nelaton's Splint.



over the olecranon, should be tightened from day to day as the swelling recedes. Plaster of Paris is not suitable as a dressing for this fracture. Suture of the fragments by wire or kangaroo tendon is justifiable, is not attended with much danger, but is seldom called for unless the injury is compound.

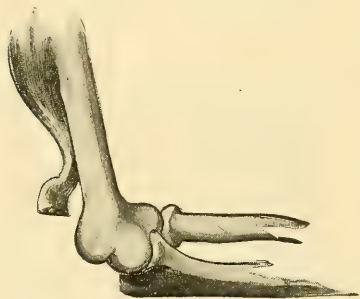


Fig. 113. Fracture of the Olecranon Process of the Ulna.

#### Fracture of the Shaft of the Ulna.

—CAUSE. This fracture is produced by direct force, received from blows or in machinery accidents.

**PATHOLOGY.** The line of fracture is usually transverse and little or no deformity exists, as the radius acts as a splint and prevents over-riding. The pronator quadratus muscle may draw the lower fragment into the interosseous space. (Fig. 115.)

**SYMPTOMS.** Crepitus is invariably found. There is some loss of function, and pronation and supination are accompanied with pain.

**PROGNOSIS.** Good bony union follows this injury; an interosseous bridge may be formed between the bones of the fore-arm, after which supination and pronation will be forever lost. This same result often follows fracture of the shaft of the radius. (Fig. 104.)

**TREATMENT.** Anterior and posterior straight splints, supplemented with anterior and posterior interosseous pads, are applied while the elbow is flexed at a right angle and the hand held midway between supination and pronation. The treatment is continued for five weeks. (Fig. 107.)



Fig. 114. Hamilton's Dressing for fractured Olecranon.

**Lower End of the Ulna.**—CAUSE. The lower end of the ulna is rarely fractured. Direct force produces it when it does occur.

**PATHOLOGY.** The line of fracture is oblique, and is accompanied by partial dislocation of the ulna from the carpus.

**SYMPTOMS.** Deformity, abnormal mobility, crepitus, swelling, pain and loss of function are observed.

**PROGNOSIS.** Fibrous union occasionally takes place, but usually good bony union should be obtained.



Fig. 115. Fracture of Shaft of Ulna.

**TREATMENT.** The same as for the shaft of the ulna. (Fig. 107.)

**Both Bones of the Fore-arm.**—This injury occurs more frequently than fracture of either bone of the forearm separately.

**CAUSE.** These bones are broken by direct force. When arms are drawn between the belt and the fly-wheels in machine shops both bones of the forearm are often fractured.

**PATHOLOGY.** Both bones of the forearm may be fractured at any point, but in the majority of cases they are broken in the middle third and at the same level, and the line of separation is usually transverse,

(Fig. 116). Over-riding is present with some angularity of the fragments. These fractures are often multiple, either in one or both bones.

**SYMPTOMS.** Abnormal mobility, complete loss of function, crepitus, are attending symptoms. The hand is generally found supinated.

**PROGNOSIS.** Bony union takes place in five weeks, but the formation of a callus between the bones at the seat of injury is liable to occur, in which case the power of supination and pronation is lost. Some angularity may permanently exist, although supination and pronation may be perfect. When the fracture of either of these bones is multiple (when both bones are broken) the chances of obtaining a perfect and useful arm are exceedingly small. The prognosis should be guarded.



Fig. 116. Fracture of both bones of forearm.

**TREATMENT.** The anterior and posterior straight splints as advised for fracture of the ulna and radius should be employed (Fig. 107). When the fracture is multiple it is well during the first two weeks of the treatment to anesthetize the patient every third day and forcibly place the fractured ends of the bone in apposition. A pad in the shape of a card of about one quarter of an inch in diameter is placed along the anterior and posterior surfaces of the arm parallel to the bones of the forearm. This is used to force the muscle into the interosseous space. Some surgeons do not think it necessary to use this pad and claim that the firm pressure of the splints upon the soft structures tends to crowd them between the bones, thus forming an interosseous pad.

## CHAPTER IV.

### FRACTURES OF THE HUMERUS.

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**Location.**—Fracture of this bone may occur at the head, anatomical neck, through the tubercle, surgical neck, through any part of the shaft above the condyle, and above and between the condyles, at either condyle and at either epi-condyle.

**Head.**—This accident rarely occurs and is difficult to determine. By head is meant that part of the bone which is contained within the glenoid cavity.

**CAUSE.** Direct blows received on the shoulder produce the fracture.

**PATHOLOGY.** No change about the shoulder is noticed and no injury to the soft tissue about the joint is ever observed. The line of separation of the bone is the only pathological change.

**SYMPTOMS.** Crepitus is sometimes found, but at times the head of the bone rotates with the shaft, although it may be broken, and the crepitus cannot be elicited. Slight loss of function, lack of abnormal mobility, absence of deformity, with pain and slight swelling aid the surgeon in establishing a diagnosis.

**PROGNOSIS.** Necrosis of the head of the bone may take place. In the majority of cases good union occurs, and no loss of function remains.

**TREATMENT.** The arm should be placed at the side of the body and the fore-arm in a sling. A small axillary pad is used, and the treatment is continued for six weeks. Adhesive plaster or roller bandage is employed to retain the arm and the fore-arm in the above position.

**The Anatomical Neck.**—This fracture is rare, and, anatomically speaking, occurs at a point where the capsular ligament is attached to the neck of the humerus. It does not always confine itself to this level, but at times it leaves the capsular line and extends a little away from it.

**CAUSE.** It is caused by direct force applied over the shoulder or by falls upon the shoulder.

**PATHOLOGY.** The line of fracture is transverse. The upper end may be pushed aside and the fractured surfaces no longer remain in

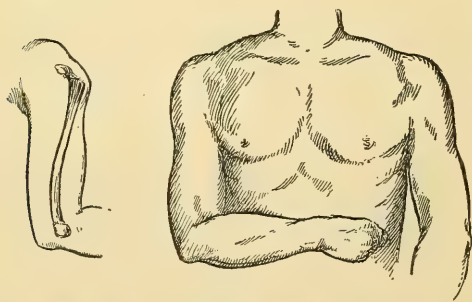


Fig. 117. Separation of the Epiphysis.

apposition, or the head of the bone may rotate.

**SYMPTOMS.** The acromion process of the scapula is prominent, and a depression is found beneath it. Abnormal mobility is marked and the arm hangs down by the side of the body. Crepitus is sometimes found, but if the fracture is impacted it cannot be detected. Loss of function, pain, swelling and ecchymosis are present.



**PROGNOSIS.** Union is usually good, and perfect use of the arm follows. Some loss of function may result or non-union may occur; paralysis of the muscles of the arm has followed this fracture. Fibrous union may take place or a false joint may be established.

**TREATMENT.** After the reduction, which is often difficult to accomplish, the fragments are best maintained in place by simply bringing the arm to the side of the patient and retaining it there by a roller bandage, at the same time placing the fore-arm in a sling across the chest. A small axillary pad and shoulder cap are used.

**Through the Tubercles or of Either Tubercle.**—These injuries are rare. Separation of the epiphysis is not classed with these cases and belongs to the division of “Fracture of the Surgical Neck.”

**CAUSE.** Falls upon the shoulder and direct blows produce these fractures.

**PATHOLOGY.** Since the principal muscles have their attachments at or near the tubercle there is little or no deformity and the line of fracture is usually oblique. When either tubercle is fractured the line of fracture is necessarily longitudinal.

**SYMPTOMS.** Crepitus, swelling, pain and loss of function are noticed.

**PROGNOSIS.** The results obtained are good and union is usually accomplished in about four weeks.

**TREATMENT.** The dressing advised for fracture of the “Anatomical Neck” is used.

**Fracture of the Surgical Neck.**—Separation of the epiphysis (Fig. 117) will be considered under this head.

**THE SURGICAL NECK.**—This variety includes all fractures below the tubercles and above the insertions of the latissimus dorsi and pectoralis major muscles. (Fig. 118.)

**CAUSE.** Direct, and sometimes indirect, injury, the force of the blow being transmitted from the elbow, is responsible for this variety of fracture.

**PATHOLOGY.** The actions of the pectoralis major and latissimus dorsi muscles, together with the teres major muscle, draw the lower fragment inward and forward and, the arm being fixed in this position, the contraction of the deltoid muscle draws the elbow off obliquely from the side of the body.

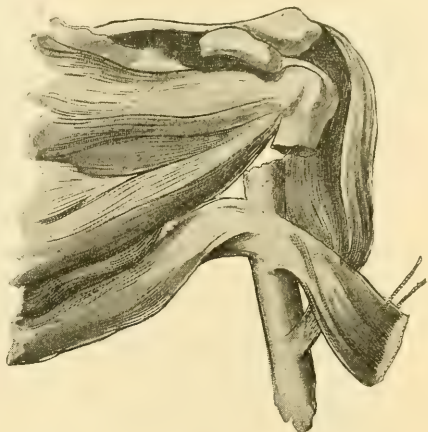


Fig. 118. Fracture of Surgical Neck.

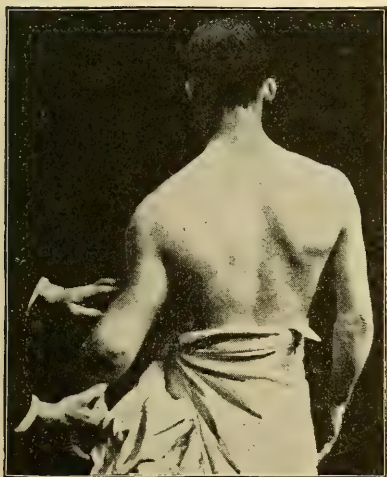


Fig. 119. Author's case of Fracture of Surgical Neck.

**SYMPTOMS.** This fracture is easily detected, but when accompanied by dislocation of the head of the humerus, it is difficult to diagnose. Crepitus is not always present, because the ends of the bones are not in apposition. The depression found beneath the acromion process in the variety known as "fracture at the anatomical neck" is not present, but a hollow is found an inch or so farther down. On rotation of the shaft the head of the bone does not move. Loss of function, pain, swelling, and abnormal mobility are constant.

#### DIFFERENTIAL DIAGNOSIS (Hamilton).

##### *Fracture of the Surgical Neck.*

###### CAUSE.

1. Generally from direct blows, but may be from counter force.
2. Preternatural mobility, not invariably present.
3. Crepitus is sometimes found.
4. When fragments are placed in apposition there is constant tendency for the deformity to recur.
5. Hand can be placed on the opposite shoulder while the elbow rests on the chest.
6. No depression immediately beneath the acromion process is found, but a hollow is observed two or three inches further down.
7. Head of the bone, unless impacted, does not partake of the movements of the shaft.
8. Elbow hangs by the side of the body unless the displacement of fragments is very great, when it will be carried away from body.
9. Arm is shorter than normal or unchanged in length.

##### *Dislocation of the Head of Humerus (Sub-Glenoid).*

###### CAUSE.

1. Generally from falls upon the elbow or hand.
2. Preternatural immobility.
3. Crepitus is never found.
4. When the deformity is reduced little inclination of the displacement to recur is observed.
5. Hand cannot be placed on opposite shoulder while the elbow rests against the chest.
6. Depression is found immediately beneath the acromion process.
7. Absence of the bone from the socket, which is found to move with the shaft when the latter is moved.
8. The elbow cannot be pressed to the side of the body. It is usually carried away from the side of the patient, and at the same time is carried a little forward or backward.
9. Lengthening will be found in the sub-coracoid and sub-glenoid varieties, and shortening in the sub-clavicular and sub-spinous varieties.

**PROGNOSIS.** Usually good bony union follows, but some shortening will remain. Union should take place in about six weeks.

**COMPLICATION.** This fracture may be associated with a sub-glenoid dislocation of the shoulder. This complication will be considered under dislocation of the shoulder. (Fig. 120.)

**TREATMENT.** In attempting reduction the method advised by Moore should be followed. The arm is carried forward, upward and outward, so as to meet the upper fragment, which is held firmly by the capsule but tilted upward. When no deformity exists a shoulder cap (Fig. 127), held in place by means of a spica bandage of the shoulder, is used. The arm is brought to the side of the body and held there by a few circular turns of a roller bandage around the body, the skin surfaces of the arms and chest being separated by means of a folded towel. The bandage extends to the elbow, and the dressing is completed by carrying the fore-arm across the body and placing it in a hand sling. If much over-riding occurs Swinburne's splint (Fig. 121) may be used. A narrow internal splint of felt may be employed, but care should be taken that it does not press into the axilla or into the bend of the elbow. Extension is seldom required for fracture at this point, but if it is necessary to use any apparatus for this purpose the one devised by Clark (Fig. 128) is



preferable to all others. Skin bandages should not be employed in this or any other fracture. Plaster of Paris dressing, including the shoulder and running down to the elbow, is preferred by some surgeons. This

dressing is not practical when much over-riding is present, because it can not be applied so as to have the slightest influence upon the over-riding.

**Separation of the Epiphysis.**—This usually occurs in young children, but may take place at any time up to the age of twenty.

**PATHOLOGY.** The line of separation is usually transverse and the lower fragment is displaced inward and is found on the inside of the upper fragment, which includes the tuberosities of the humerus.

**SYMPTOMS.** These are essentially the same as in fracture of the surgical neck.

**PROGNOSIS.** The prognosis should be extremely

Fig. 120. Fracture of Surgical Neck Accompanied by Dislocation (Sub-Glenoid).

guarded as development of the arm has been known to cease from the time of fracture (Fig. 122). Good bony union, however, follows in the majority of cases.

**TREATMENT.** This is the same as in fracture of the surgical neck. (See preceding page.)

**Fracture of the Shaft of the Humerus.**—The shaft of the humerus may be broken at any point from the surgical neck down to the condyles.

**CAUSE.** Direct violence received over the line of separation and muscular contraction are stated as the causes of this injury. Ball players are subject to this fracture from muscular contraction.

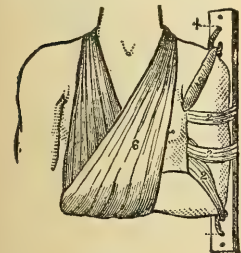


Fig. 121. Swinburne's Dressing.

**PATHOLOGY.** When the fracture is the result of direct violence the line of separation will be transverse or oblique. The fracture is frequently multiple. As the bone may be broken at any point and the line of separation may be oblique in any direction, the deformity will vary according to the position of the break and the

direction of the obliquity. If the fracture is between the insertions of the pectoralis major and the latissimus dorsi and the teres major muscles, and above the insertion of the deltoid muscle, the upper frag-



Fig. 122. Showing Lack of Development after Fracture.



ment will be drawn inward and the lower fragment outward and upward (Fig. 123). If the break is below the insertion of the deltoid muscle and if the line of fracture is oblique from above downward and backward



Fig. 123. Fracture of Shaft of Humerus.

the action of the biceps, brachialis anticus and triceps muscles will cause the lower fragment to over-ride the upper one and be displaced inward. (Fig. 124). When the fracture is produced by muscular action alone the line of fracture is transverse and there is little tendency to displacement of the fragments, and the break usually takes place in the middle third.

**SYMPTOMS.** Shortening is ascertained by measuring from the acromion process of the scapula to the point of the elbow or to the styloid process of the ulna, increased circumference of the limb over the seat of fracture,

ure, abnormal mobility, loss of function, pain, swelling, ecchymosis, and crepitus are prominent symptoms. In the transverse and dentated varieties neither crepitus nor shortening will be found.

**PROGNOSIS.** Non-union has been observed frequently in fractures of the shaft of the humerus. Paralysis of the muscles supplied by the musculo-spiral nerve has also been observed (Fig. 126). Sometimes severe cellulitis (Fig. 84) may be anticipated. Union, however, if it takes place, is prompt and occurs in about six or eight weeks.

**TREATMENT.** A skin bandage should not be used; a shoulder cap (Fig. 127) which reaches nearly to the elbow and an internal splint of felt or leather which extends from the axilla to the elbow should be employed. The elbow is thus placed at a right angle and the arm is supported by a hand sling. Moulded splints (Fig. 125) including the shoulder, arm, elbow and forearm are also employed in suitable cases—that is, where there is very little shortening. Plaster of Paris dressing, when cautiously employed, may be advantageous where no shortening is present. Extension is often necessary. Clark's method is the best.



Fig. 124.  
Fracture of Shaft of Humerus.

*Clark's Method.* The arm is flexed at a right angle and a strip of rubber adhesive plaster two and one-half inches wide by twelve inches long is divided from either end into three tails and applied below the seat of fracture so as to leave a loop hanging below the point of the elbow into which may be hooked the weight. (Fig. 128.) While the patient is at rest at night the weight may be carried over the end of the bed by means of a cord and pulley. Extension may be made by utilizing the weight of the forearm and dressing it in an extended position, employing long moulded splints running from the axilla to the hand.



Fig. 125.  
Hamilton's Dressing.

Some extension is obtained by placing the hand in a "hand sling" instead of an arm sling, leaving the elbow free.

### Fracture at the Base of the Condyles.

—This fracture occurs infrequently and at times is complicated with a fracture between the condyles, making what is known as a "T" fracture.

Care should be taken not to confound this fracture with dislocation of both bones of the forearm backward.

**CAUSE.** The humerus is broken at this point by falls upon the elbow or by direct force applied over the posterior aspect of the arm.

**PATHOLOGY.** The line of fracture is oblique from before upward and backward, and the lower end of the upper fragment will be found to project into the bend of the elbow. This deformity is aided or caused by the action of the biceps, brachialis anticus, and the triceps muscles.

**SYMPTOMS.** Pain and swelling appear very early. Crepitus, shortening, ecchymosis and abnormal mobility are present. The lower end of the upper fragment may be felt in the bend of the elbow.

**DIFFERENTIAL DIAGNOSIS** in fracture above the condyles and dislocation of both bones of the forearm backward:

#### FRACTURE OF CONDYLES.

1. It is caused by falls or direct blows upon the elbow.
2. Shortening, determined by taking the acromion process and internal condyle as salient points.
3. Crepitus is present.
4. Deformity tends to recur after reduction.

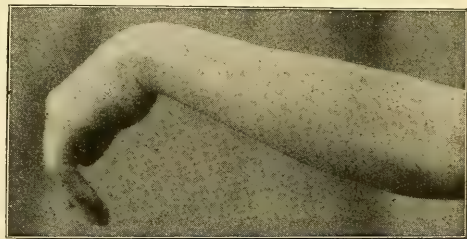


Fig. 126. Wrist-drop after injury to Musculo-Spiral Nerve—Bishop.

#### FORE-ARM DISLOCATION.

1. It is caused by falls upon the hand, rarely from direct blows received at the elbow.
2. Shortening, determined by measuring acromion process of the scapula to the olecranon process of the ulna, not found by measuring from the acromion process of the scapula to the condyles of the humerus.
3. Absence of crepitus.
4. Deformity does not tend to recur after reduction.

**PROGNOSIS.** Bony union is usually obtained at the end of five weeks, but some deformity at the elbow joint is liable to remain. Limited use of the elbow or perhaps permanent ankylosis may follow this injury.



**TREATMENT.** The inflammation in and about the joint should be allayed as early as possible, and complete rest in loose dressings should be afforded. After the swelling has begun to subside moulded splints should be applied to the arm and forearm and the arm kept extended.



Fig. 127.  
Shoulder Cap

If the flexed position is used a right angle anterior or posterior splint is employed which reaches from the shoulder down to the wrist. If plaster of Paris is used for a splint it must be at once cut down in the centre to allow early inspection of the arm.

### Fracture at the Base and Between the Condyles.

—CAUSE. This fracture is produced by direct force, applied at the elbow.

**PATHOLOGY.** In this fracture, also called a “T” fracture, the lines of separation run longitudinally between the condyles and transversely or obliquely at the base of the condyles. There is a communication between the joint cavity and the lines of fracture. These fractures are frequently compound.

**SYMPTOMS.** Crepitus, ecchymosis, pain and swelling are present. A noticeable increase in width of the joint between the condyle is a characteristic symptom. Abnormal mobility is always present, also loss of function.

**PROGNOSIS.** Violent inflammation frequently destroys the joint and if the fracture is compound resection of the elbow or amputation of the arm may be necessary. Some degree of ankylosis follows in every case, and in many instances the joint is absolutely useless.



Fig. 129. Fracture of  
Base of Condyles.

**TREATMENT.** This does not differ from that advised for fracture of the base of the condyles.

**Fracture of the Internal Condyle.**—CAUSE. This fracture occurs frequently as the result of direct injury.

**PATHOLOGY.** The line of fracture runs from outside the base of the condyle near the epi-condyle, downward and outward into the joint.

**SYMPTOMS.** The condyle is displaced upward and backward and may be felt to move independently of the rest of the humerus. Crepitus is usually found. Some abnormal lateral motion and impaired flexion and extension are noticeable.

**PROGNOSIS.** Imperfect use of the joint is the usual result, but union occurs in about four weeks.

**TREATMENT.** The treatment should be carried out with the arm in an extended position. In this the carrying function (Fig. 130) may be maintained and the liability to ankylosis is not great enough to warrant treating the limb in a flexed position. Every physician can testify that with the arm in a

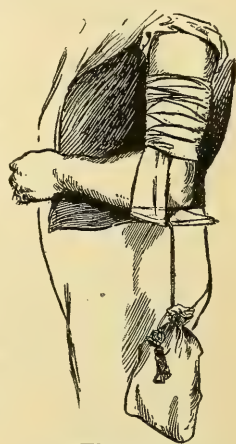


Fig. 128.  
Clark's Method of Ex-  
tension.



flexed position, when an injury has occurred at the elbow, any kind of displacement at the elbow may persist, and even by comparison with its fellow of the opposite side, this cannot be detected while the arm is thus flexed. When the arm is extended it may easily be compared with the sound side and any altered condition at the elbow will be readily detected. Even if ankylosis does take place it is not likely to be firm, and if broken up there is little tendency for it to recur. When the arm has been treated in a flexed position and ankylosis takes place it is more likely to be bony than when the arm has been treated extended. The arm is placed in a straight, posterior, moulded splint of plaster of Paris or leather, which extends from the shoulder to the wrist. If the flexed position is chosen the moulded splint of plaster of Paris is used. Some surgeons prefer to place the limb in an extended position for the first few days or during the first week, and then treat the arm in a flexed position.

**Fracture of the External Condyle of the Humerus.**—**CAUSE.** It is caused by direct violence received upon the condyle.

**PATHOLOGY.** The line of fracture runs from above the condyle downward and enters the joint.

**SYMPTOMS.** Crepitus is present and the condyle is felt to move independently of the shaft of the bone. The radius is displaced backward with the detached condyle, and sometimes the ulna accompanies it. Abnormal lateral motion of the elbow joint, impaired flexion and extension are always noticed.

**PROGNOSIS.** Bony union occurs in most cases, and good use of the arm usually follows this injury. Ankylosis may, however, take place.

**TREATMENT.** The treatment advised for fracture of the internal condyle should be followed.

**Fracture of the Internal Epi-Condyle.**—**CAUSE.** Direct injury usually inflicted by a fall is the most common cause.

**PATHOLOGY.** This injury may be a simple separation of the epiphysis. In any case it is merely a chipping off of the epi-condyle and the line of fracture never enters the joint. If any displacement occurs the epi-condyle is forced downward.

**SYMPTOMS.** A loose body may be detected in the neighborhood of the condyle. No loss of function is present. Crepitus, pain and slight swelling are constant symptoms.

**PROGNOSIS.** Little or no loss of function of the joint follows. Union may be bony, oftentimes it is fibrous.

**TREATMENT.** The treatment is the same as is advised for fracture of the internal condyle.

**Fracture of the External Epi-Condyle of the Humerus.**

**CAUSE.** Direct injury received from a fall or blow is a frequent cause.

**PATHOLOGY.** Separation of the epiphysis takes place, or a chipping off of the epi-condyle occurs, but the line of fracture never enters the joint.

**SYMPTOMS.** A loose body may be detected in the neighborhood of



Fig. 130.  
Showing  
Carrying  
Function.

the external condyle. No loss of function of the joint ever occurs. Crepitus, pain and slight swelling are observed.

PROGNOSIS. Good use of the joint always follows this injury.

TREATMENT. Immobilization is carried out best by the methods advised for fracture of the internal condyle.

## CHAPTER V.

### FRACTURES OF THE FACIAL BONES.

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**Fracture of Superior Maxillary Bone.**—CAUSE. Direct violence produced by falling objects or blows is among the common causes.

**PATHOLOGY.** The fracture is usually comminuted, or compound or both, and the displacement, although very great, may be easily overcome.

**SYMPTOMS.** Crepitus, swelling, loss of function and deformity are observed. Two or more teeth may be loosened or even the alveolar process may be fractured.

**PROGNOSIS.** Union takes place very rapidly and even where loose fragments of bone are known to exist they should be retained in place, because in the majority of cases good union occurs even when the injury is of the compound variety.

**TREATMENT.** The lower jaw is held firmly against the upper one by a Barton bandage, in this way acts as a splint to retain the broken fragments in apposition. Wiring of the fragments will not be necessary in the majority of cases.

**Fracture of the Malar Bones.**—CAUSE. Direct violence is always the cause.

**PATHOLOGY.** This fracture is frequently of the compound variety. It may be multiple or comminuted.

**SYMPTOMS.** Loose pieces of bone are freely movable beneath the skin, although occupying a normal position.

**PROGNOSIS.** Union is rapid on account of the very free supply of blood to the periosteum and soft tissues, and in no case should the removal of these loose pieces be permitted.

**TREATMENT.** A compress which is held in place by a roller bandage is to be employed. It is well, however, to immobilize the lower jaw by one of the various dressings for this purpose.

**Fracture of the Nasal Bones.**—CAUSE. Direct violence inflicted by blows, usually made by the fist. As in fracture of the malar bones the injury is frequently compound, and almost invariably comminuted.

**PATHOLOGY.** The skin and soft tissues may be extensively lacerated over the seat of the fractures, or the mucous membrane lining the nose may be broken either by the object which produces the injury or by the fractured surfaces of the bones lacerating the mucous membrane.

A fracture is just as truly compound where the communication between the atmosphere and the seat of fracture is by way of the mucous lining of the nostrils as when this communication is through the skin surface.

**SYMPTOMS.** Great swellings, pain and ecchymosis are always present. The septum may be deflected to either side, and one or both nostrils may be closed. Great deformity is apparent in all cases.

**PROGNOSIS.** Repair usually takes place very rapidly, but with more



or less deformity. The nose may be permanently deflected to one side or the other, or it may be flattened. The altered septum often permanently obliterates one nostril.

**TREATMENT.** Reduction is best accomplished by forcibly placing the fragments in apposition by the use of a silver catheter. The nostrils may be plugged by pieces of sterilized gauze or by means of a soft catheter. Antiseptic solutions should be employed daily to cleanse the nose, and the packing be readjusted.

**MASON'S DRESSING.** This plan of treatment is very satisfactory. It consists of a stout pin which is used to transfix the nose, and a piece of gauze or a rubber band which is wound in the shape of a figure eight around the ends of the pin and over the nose.

**Fracture of the Lower Jaw.**—**CAUSE.** Direct violence made by blows or kicks. Falling objects often produce this fracture. Such accidents frequently happen to sailors and prize fighters.

**PATHOLOGY.** The line of separation may take place in any portion of the jaw and be oblique or transverse, and the fracture is frequently compound. It may be multiple, in which case the intervening fragment will be found greatly displaced. Multiple fractures of the jaw are quite common.

**SYMPTOMS.** Crepitus, abnormal mobility and loss of function are always present. The mobility of the fragments will be very great when the fracture is multiple. Over-riding of the fragments takes place in all complete fractures of the jaw.

**PROGNOSIS.** Union is usually of a bony nature. A little deviation of the jaw to one side or the other is often noticed. In compound fractures of the lower jaw union may be delayed beyond the period of the six weeks ordinarily required for repair. Temporary or lasting paralysis of the muscles of the face often follows fractures of the inferior maxilla.

**TREATMENT.** Reduction is easy to accomplish in every case, but some force may be required to place the fragments in apposition, on account of the over-riding. After reduction, however, it is often very difficult to retain the fragments in their proper places, and many plans have been suggested and many splints advised for the treatment of this



Fig. 131.  
Pasteboard Splints  
for Fracture of  
Lower Jaw.

injury. Where little tendency is shown by the fragments to assume their natural positions the only dressing required will be a four-tailed bandage or Barton's or Gibson's bandage, reinforced by a splint made of pasteboard or felt, cut into the shape shown in Fig. 131. In this way the surfaces of the teeth of the two jaws are held firmly together and fractures treated in the above manner will be followed by very satisfactory results. When the fragments are easily displaced after reduction is accomplished it is necessary to wire the fragments, to use one of the many forms of inter-dental splints, or to hold the fragments in place by a metallic clasp bound around the teeth, these clasps being joined by

ligatures or metallic rods. Gutta percha, softened by heat, may be interposed between the surfaces of the teeth of the upper and lower jaws before the adjustment of the head bandages. This acts as a partial splint and in

a measure fixes the jaws. When it is considered advisable to wire the fragments, and in the author's hands this method has proved to be a very valuable one, the operation should be performed early. Silver wire or kangaroo-tendon should be selected for sutures. Two sutures will usually be sufficient to retain the fragments in place, and the drill hole should be made below the alveolar border, if possible. Immobilization of the fragments of a fractured jaw by ligatures tied around sound teeth, or by adjusting clasps, reinforced by ligatures, to firm, unnecrosed teeth has been attempted by every surgeon. A few trials only have been necessary to convince every experimenter that these measures cause much mischief, ruin many perfect teeth, and are unnecessary when other and less severe methods are satisfactory.

## CHAPTER VI.

### FRACTURES OF THE HYOID AND THORAX.

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**Fracture of the Hyoid Bone.**—**CAUSE.** This bone is rarely fractured. It occurs from direct violence. It has been noticed in executed people where death has been caused by hanging.

**PATHOLOGY.** The line of separation may occur at any part of the bone.

**SYMPTOMS.** Where death does not follow immediately more or less of painful deglutition or embarrassed breathing will be noticed. Crepitus is usually present, as are pain, swelling and ecchymosis.

**PROGNOSIS.** The complications which accompany this injury are usually so great that death early relieves most patients from their suffering. When the injury has been caused by direct force of a slight degree good union, although fibrous, may be anticipated.

**TREATMENT.** The patient should be placed on a light diet, or fed entirely by the rectum. The stomach tube should never be used. It matters little whether the patient keeps his neck flexed or extended. Rest in bed with the head well elevated should be demanded of the patient.

**Fracture of the Sternum.**—This fracture has always been considered a rare accident, but observations in the dissecting room show that the injury is not uncommon.

**CAUSE.** A direct blow upon the sternum or upon the shoulder may produce it. It occurs when athletes fall and strike some prominent object.

**PATHOLOGY.** The line of fracture is usually transverse, and the lower fragment is displaced upward above the upper one.

**SYMPTOMS.** This injury may be apparent at once, especially if it occurs in a thin person.

Swelling and pain are prominent symptoms and efforts of respiration are painful. Crepitus may be recognized during the act of respiration, especially when the shoulders are thrown backward. Emphysema and marked dyspnea are often present.

**PROGNOSIS.** There is no reason for apprehension unless some important structure is injured, as the trachea, for example. Union is prompt, although a marked prominence at the seat of fracture will be observed.

**TREATMENT.** Immobilization may be accomplished by a few turns of a roller bandage placed around the chest, together with a posterior figure-of-eight of the shoulder. Reduction is not difficult and is accomplished by directing the patient to sit or stand erect with the shoulders thrown back, requiring him to take a full inspiration. It is often difficult to retain the fragments in apposition and the constant tendency of the deformity to recur is always noticed.

**Fracture of the Ribs.**—The position which the ribs occupy in order to protect the viscera predisposes them to injury.



**CAUSE.** These injuries are produced by direct force applied to the chest; rarely by muscular contraction.

**PATHOLOGY.** The fracture may be complete or partial, and is often compound. When entrance of the atmospheric air to the seat of fracture is by way of the lungs the fracture is just as truly compound as when there is some communication through the skin. When multiple the displacement is greater than when single, but, in any form, it is usually inward or outward. Green-stick fractures of the ribs are common. The first three or four ribs are seldom fractured.

**SYMPTOMS.** Pain on taking a deep respiration and on moving is always noticed. Crepitus is difficult to make out unless two or more ribs are simultaneously broken. Spitting of blood and cellular emphysema are symptoms which are pathognomonic of a fractured rib.

**PROGNOSIS.** When the lungs or pleura have not been injured the prognosis is good. The dyspnea may be so pronounced as to prevent the patient from lying down. Fig. 82 shows a case where surgical emphysema followed a fractured rib, and Fig. 83 pictures the man after the emphysema had disappeared.

**TREATMENT.** The best dressing consists of adhesive plaster straps, cut in strips, one-half inch wide, and half the diameter of the trunk in length, applied as shown in Fig. 132. No dressing should be applied for three or four days when emphysema is present.

#### **Fracture of the Cartilages of the Ribs.**

—Fractures of the cartilages of the ribs are produced by the same causes that fracture the ribs. They may be transverse or longitudinal and they may occur at any point, but ordinarily the line of



**Fig. 132.**

**Adhesive Plaster Strips for Fracture of Ribs.**



**Fig. 133. Fracture of Scapula.**

separation will take place near the junction of the cartilages and the ribs. The pathology, symptoms, prognosis and treatment are the same as in fracture of the ribs.

**Fracture of the Scapula.**—The scapula may be fractured at the body, neck, acromion process, coracoid process or glenoid fossa.

**Body.** The angles and spine of the scapula are included in this division. This part of the bone is well protected by muscles, and the force required to fracture it is very great.

*Cause.* Produced by direct violence.

*Pathology.* The swelling comes on early. The line of fracture may be oblique or transverse. The fracture is very often of the comminuted variety.

*Symptoms.* Swelling, pain over the seat of fracture and crepitus are present.

*Prognosis.* Little loss of function follows, but considerable deformity always exists.

*Treatment.* The best method of immobilization is to place the arm at the side of the body, raising the elbow, carrying the hand across the chest. The application of the second turn of Sayre's dressing for fractured clavicle would answer very well (Fig. 138). A pad placed over the seat of fracture is often useful to retain the fragments in apposition.

**NECK.** By fracture of the neck is meant fracture of the surgical neck, or through the semi-lunar notch behind the coracoid process. It occurs infrequently.

*Cause.* It is produced by falls upon the shoulder.

*Pathology.* Displacement downward of the whole glenoid cavity, simulating a downward dislocation of the humerus.

*Symptoms.* The head of the humerus may be felt in the axilla. Prominence of the acromion process and a depression under it will be noticed. The coracoid process moves with the humerus. Crepitus and recurrence of the deformity after reduction are prominent symptoms.

*Prognosis.* Impaired function or perhaps paralysis of the arm may follow.

*Treatment.* The head of the humerus should be elevated, thereby raising the glenoid cavity into its proper position. A pad is placed in the axilla, the arm confined to the side of the body by a roller bandage and the hand placed in a sling.

**ACROMION PROCESS.** This is a common injury, but it is often passed unobserved.

*Cause.* It is produced by direct violence or falls upon the shoulder. People when falling downstairs or out of wagons often receive this fracture.

If the fracture is posterior to the acromio-clavicular articulation, or at the articulation of the scapula with the clavicle, the shoulder will drop forward, downward and inward, as in fracture of the clavicle; but if the fracture is in front of this articulation the broken end will be felt as a movable body over the point of the shoulder, and the position of the shoulder will not be altered.

*Prognosis.* At times the accompanying dislocation of the clavicle cannot be kept permanently reduced and some deformity will exist, but good use of the arm usually follows. The union is often fibrous.

*Treatment.* Velpeau's dressing should be used (Fig. 136). The description of this dressing is on page 460.

**CORACOID PROCESS.** *Cause.* This fracture is rare. Direct violence received over the point of the shoulder produces this injury.

*Pathology.* The detached portion of the scapula will be drawn downward by the combined efforts of the short head of the biceps, coracobrachialis, and pectoralis minor muscles, but unless the coraco-clavicular ligament is torn this cannot occur to any great degree. (Fig. 134).

*Symptoms.* Crepitus may be felt and is at times the only symptom present. Some loss of function will be noticeable.

*Prognosis.* Union is usually fibrous, but it takes place promptly, and disability is never noticed.

*Treatment.* The best dressing is Velpeau's. (Fig. 136).

**Fracture of the Clavicle.**—The clavicle is broken more often than any other bone, and the greatest number of cases occur in young children. Fracture of this bone may be complete or incomplete, and is rarely comminuted or compound.

**CAUSE.** It is usually broken by indirect violence, and the force is received by a fall upon the hand or upon the shoulder. Greenstick fractures are not uncommon in children.

**PATHOLOGY.** The line of fracture may be either transverse or oblique and it occurs most frequently in the middle third of the bone and least frequently in its inner third. When it is fractured in the middle third the inner fragment is displaced upward, aided by the action of the sterno-cleido-mastoid muscle, while the outer fragment is drawn downward and inward by the weight of the arm and the action of the pectoralis major and latissimus dorsi muscles. The pectoralis minor aids in drawing this fragment upward (Fig. 135). The line of fracture at this point is usually oblique, running from above downward and inward. In thin subjects the sharp end of the inner fragment may be felt projecting upward and outward, and by throwing back the shoulder and at the same time elevating it the outer end will be felt to come from beneath the sternal end, and the deformity will be seen to disappear.

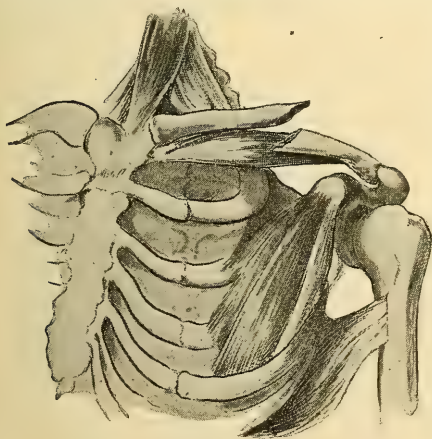


Fig. 135.  
Fracture of Clavicle at Middle Third.

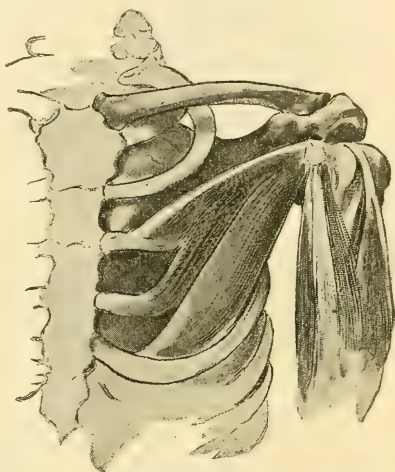


Fig. 134.  
Fracture of Coracoid Process of Scapula.

**SYMPTOMS.** Pain over seat of fracture and abnormal mobility, accompanied by very slight swelling, are observed. The deformity depends upon the location of the break. If the fracture occurs at either end it is



inconsiderable, but crepitus will be detected. When the fracture occurs in the middle third the shoulder drops downward, forward and inward, and not until after the reduction is accomplished can crepitus be detected. Loss of function has been very much exaggerated as a symptom, and in the majority of cases little inconvenience, other than slight pain, is found.

The patient supports the arm across the chest, and is prone to allow it to hang by his side.

**PROGNOSIS.** Some deformity will usually remain and the injured shoulder will be lower than the other. Non-union scarcely ever occurs, and union takes place in four weeks. Partial paralysis of the arm has been noticed in a few cases. Emphysema may appear, and when it does the prognosis should be guarded.

**TREATMENT.** The reduction is easy, but to apply a dressing which fulfills all the requirements is a difficult matter. The dorsal decubitus combined with one of the various dressings recommended for a fractured clavicle is undoubtedly the ideal treatment, but few people will submit to absolute rest in bed for such a trifling injury. Any form of dressing

which will bring the shoulder upward, backward and outward, the reverse of the displacement (downward, forward and inward), and which will keep it there will answer the purpose. Many forms of dressing have been devised, and the names of Fox, Moore and Sayre are associated with this fracture. Sayre's dressing (Fig. 137) will be found most suitable for the majority of cases. The posterior figure-of-eight made of a bandage has many objections and should not be used. When the fracture is at either end and unaccompanied by deformity Velpeau's dressing (Fig. 136) may be used, but Sayre's (Figs. 137 and 138) is to be preferred.



Fig. 136.  
Velpeau's Dressing.

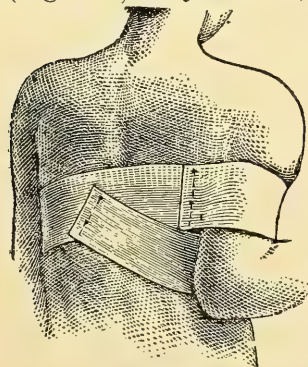


Fig. 137.  
Sayre's Dressing for Fractured  
Clavicle, 1st turn.

**VELPEAU'S DRESSING.** (Fig. 136). The hand of the injured side is placed on the sound shoulder, the skin surfaces of the arm and chest being separated by gauze or muslin. By means of a roller bandage the turns are made as follows: Beginning on the scapula of the sound side the bandage is brought over the outer side of the injured shoulder

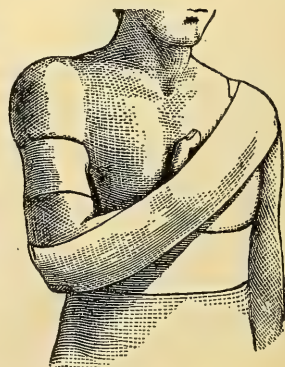


Fig. 138.  
Sayre's Dressing for Fractured  
Clavicle, 2nd Turn.

and over the arm as far from the elbow as possible, and carried through the opposite axilla to the point of starting. This turn is repeated to secure the bandage. The second turn begins where the bandage, after finishing the first turn, leaves the axilla of the uninjured side

and passes circularly around the chest over the point of the elbow. These turns are alternated; the first turn running down from the shoulder to the elbow and from the shoulder to the neck, and the second turn running up from the elbow to the shoulder.

**SAYRE'S DRESSING.** Two slips of adhesive plaster, each three and one-half inches wide and long enough to more than encircle the body, are prepared. The first piece (Fig. 137) is passed loosely around the arm below the axilla and pinned, the elbow having previously been brought backward and slightly downward, to put the clavicular portion of the pectoralis major muscle upon the stretch. The muslin covering the plaster where it touches the arm will not be removed.

The strip is carried around the body and pinned to itself on the back. The second piece is now slit in the centre for a distance of about three inches, to allow the olecranon to pass through to avoid pressure. Before it is applied the elbow is pressed forward and inward by an assistant. The plaster is now placed so that it runs over the sound shoulder and across the back of the patient, and along the forearm of the injured side. (Fig. 138).

It must be remembered that the loop of the first piece must encircle the arm immediately below the axilla and not be placed midway down the arm.

## CHAPTER VII.

### FRACTURES OF FOOT AND LOWER LEG.

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**Fracture of the Phalanges.**—This is produced by direct violence, usually from the passage of a wagon wheel or car over the toe.

**PATHOLOGY.** The line of fracture may run in any direction. The injury is usually compound. It may be multiple or comminuted, and one or more toes may be involved.

**SYMPTOMS.** Pain, swelling, crepitus and abnormal mobility are commonly present.

**PROGNOSIS.** Good union is usually obtained, but as these injuries are very frequently compounded amputation at the time of the injury is often necessary. It is not as important to save one or two of the phalanges of the foot as it is to save the digits of the hand, and early amputation is often justifiable when it would not be good surgery to sacrifice a finger injured to the same degree. A deformed toe, the result of a fracture well treated, oftentimes causes much pain and hinders the patient in walking, while the absence of one or two toes which have been properly amputated in no way inconveniences the individual. In fracture of the great toe the lower end of the upper fragment often projects directly downward, causing great pain.

**TREATMENT.** A posterior wooden splint may be used, or semi-flexible splints of felt or tin, moulded around the toe, may be employed.

**Fracture of the Metatarsal Bones.**—**CAUSE.** Direct violence of a crushing nature causes this fracture. Heavy objects which fall from a great height and strike the foot produce the majority of these injuries.

**PATHOLOGY.** Two or more bones are usually injured at the same time, and of course the displacement will be marked. Little or no deformity exists when only one bone is broken.

**SYMPTOMS.** Crepitus, pain, ecchymosis and swelling are the principal symptoms.

**PROGNOSIS.** Union takes place in about four weeks and occurs with some deformity.

**TREATMENT.** The foot is immobilized by a wide wooden splint for the first two weeks and then a plaster of Paris dressing applied.

**Fracture of the Tarsal Bones.**—The astragalus and calcaneum are fractured more frequently than any other of the tarsal bones; but fracture of any one of the tarsal bones is rare when compared with fracture of the long bones of the body.

**CAUSE.** It is usually produced by direct violence which is of a crushing nature. Falls from great heights, the patient striking upon the foot, have been known to cause fracture of the astragalus or calcaneum.

**PATHOLOGY.** The displacement is usually slight. The fracture is frequently compound, and often accompanies a Pott's fracture.

**SYMPTOMS.** Crepitus is present and the foot has a flat appearance.



A partial dislocation of the ankle, usually backward, may be present. Great swelling, pain and ecchymosis are observed.

**PROGNOSIS.** Ankylosis often occurs when the line of fracture runs directly into the joint and when the injury is compound. Good union follows but is accompanied with some deformity. In compound fractures the loose pieces of bone should be picked out.

**TREATMENT.** Reduction is accomplished by traction with flexion or extension. No permanent dressing should be applied until after the swelling has subsided and then felt or plaster of Paris splints should be employed.

**Fracture of the Tibia and Fibula.**—Both the tibia and fibula may be broken as the result of an injury, or any portion of either bone may be fractured independently of the other. These injuries are frequently compound, more so than any other fracture of the body. This is explained by the fact that the force of the injury that produces them is exceedingly great.

**CAUSE.** These fractures are produced by direct force, as when rafters of buildings or flagging used in sidewalks fall upon the leg. Kicks of horses and of men also frequently cause these injuries.

**PATHOLOGY.** When both bones are broken the fibula is usually fractured at a point higher than the tibia and the line of fracture is usually oblique, though it is sometimes transverse. The fracture may be multiple in both bones or multiple in one and single in the other, or comminuted in both. (Fig. 139).

**SYMPTOMS.** Crepitus is always present; swelling comes on early; ecchymosis is very pronounced; pain is intense, especially when both bones have been broken and there is much deformity. The foot may be inverted or everted, and when both bones are broken a great amount of shortening will be present. Abnormal mobility is always present and the sharp ends of the fragments,

especially when the line of fracture is oblique, are easily detected beneath the skin. (Fig. 80). The lower fragment usually over-rides the upper one and is found on the anterior surface of the leg. (Fig. 80).

**PROGNOSIS.** When the fracture is oblique it is almost impossible to prevent the over-riding, and the shortening and angularity which follow are inevitable. Good bony union is usually obtained, even in multiple fractures. The sharp tooth-shaped ends of the fragments may pierce through the soft tissue and skin, thereby rendering the fracture compound. Compound fractures in this region, whether produced from within outward, or whether produced from without inward, are always dangerous and difficult to treat.



Fig. 140.  
Gerdy's Extension Knot.



Fig. 139.  
Specimen in New York Homeopathic Medical College Museum. Fracture of both Bones of Leg at Different Levels.

A leg which has sustained a compound fracture and has not been sacrificed to amputation, although repair has taken place in broken bones with shortening and angularity, is a triumph to modern surgery.

**TREATMENT.** Reduction is accomplished by extension and counter extension and if the line of fracture is transverse the displacement will not recur; but if it be oblique, as is usually the case, no form of dressing will have much influence upon the shortening. Extension applied from the ankle by means of a "Gerdy Knot" (Fig. 140) or a gaiter cannot be worn long enough to be of any practical benefit. The sensitive and tender malleoli, covered as they are merely by skin, will not bear pressure for any length of time. Some little extension may be obtained by the use of a "Keen Splint" (Fig. 89), the anterior portion of which has been strengthened by a piece of tin. When these cases first come to the notice of the surgeon the leg should be placed on a pillow (Fig. 86), and should be given rest, free from fomentations of all kinds for a period of two or three days until the swelling has partially subsided. The deformity should be reduced as soon as possible by extension and counter extension. This dressing should be followed by one composed of anterior and posterior felt splints (Fig. 141) or a "Keen Splint" (Fig. 89). If extension is required a "Volkman's Sliding Rest" should be used. (Fig. 142). A dressing of plaster of Paris, arranged so that the leg may be readily elevated is a very satisfactory dressing. It should never be employed until after the danger of constriction of the limb has passed.

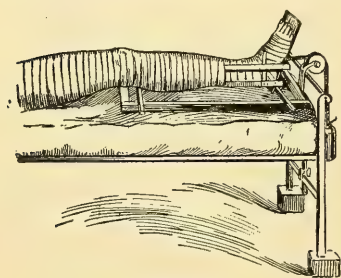


Fig. 142.  
Volkman's Sliding Rest.

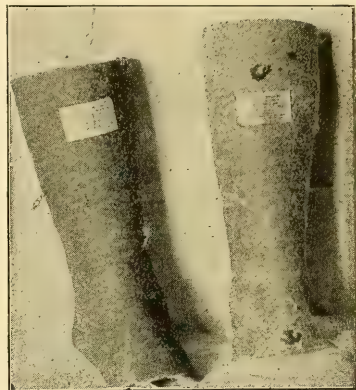


Fig. 141.  
Anterior and Posterior Splints.

Plaster of Paris dressings should be used with caution, well padded, and opened down the center to permit of inspection. This form of dressing, while it is the best at command, is, as has been said in the introduction to fractures, the most dangerous, and the student cannot be cautioned too often as to its dangers.

*Keen's Splint.* This dressing consists of three distinct parts, or splints, called anterior (Fig. 89, a), posterior (Fig. 90, b), and lateral or (Fig. 91, c) "U" shaped.

The anterior and posterior splints are made as follows: While the leg is held in extension by an assistant the dresser takes the measurement of the anterior and posterior aspects of the leg from the toes to the knee. The plaster of Paris bandage, two inches and one-half wide and four yards long, is moistened and is spread upon a table in consecutive turns made upon each other. The length of these turns so placed should correspond with the measurements taken for the anterior and posterior splints. The anterior and posterior splints are now in two straight pieces. While the bandages are still moist and limp the splints are applied, one to the anterior and one to the posterior surfaces of the leg, and in this position are allowed to dry. When hardening has begun they should be removed and set aside in the air for two hours, so that



they may be thoroughly dried before the dressing is re-applied. The "U" shaped splint is made in the same fashion, the measurement having previously been taken from the upper end of the fibula down the outer aspect of the leg under the instep, and up the inner side of the leg to the upper end of the tibia. It will be necessary to use two bandages instead of one for this portion of the splint. When the splints are thoroughly dried they should be re-applied to the leg, which has been previously padded with absorbent cotton, especially over the bony prominences.

If the fracture is tooth-shaped and the sharp ends threaten to pierce through the skin it is good surgery to cut down upon the fracture, saw or snap off the sharp ends of the fragments and either wire them together or treat the condition after the ordinary fashion of any compound fracture. The treatment should be continued for six weeks at least. It usually requires eight weeks before the patient is able to walk.

Many of the forms of suspension advised for fracture of the femur are very useful for fracture of the leg. Among these may be mentioned Smith's anterior wire splint (Fig. 94), Hodgen's (Fig. 93), and the plaster of Paris with iron bands (Fig. 87) that are in use.

**Fracture of the Tibia.**—**CAUSE.** Fracture of the tibia alone is often caused by the kick of a horse or of a person.

**PATHOLOGY.** The displacement is absent or slight, as the fibula remains intact and acts as a splint, keeping the broken ends of the bone in place. This fracture is frequently compound, the injury being of such a nature that the wound is of the punctured variety.

**SYMPTOMS.** Slight abnormal mobility is present. Crepitus is difficult to detect, but swelling and pain are present.

**PROGNOSIS.** Good union occurs and takes place promptly in about five weeks, at the end of which time the patient may be allowed to walk.

**TREATMENT.** Extension will rarely be required. Posterior felt splints may be used. A plaster of Paris dressing, employed after the swelling has subsided, is a useful one, but a "Keen Splint" (Fig. 89) answers the requirements better than any other.

**Fracture of the Lower End of the Tibia.**—This fracture occurs frequently and is nearly always accompanied by a fracture of the fibula, in which case it is often called a Pott's fracture.

**CAUSE.** The injury is usually produced by direct force. It has occurred while walking, the patient suddenly twisting the ankle.

**PATHOLOGY.** The external malleolus may be simply chipped off, or the bone may be fractured through its entire thickness two or three inches higher.

**SYMPTOMS.** Crepitus, eversion of the foot, loss of function, abnormal mobility, pain, swelling and ecchymosis are the leading symptoms.

**PROGNOSIS.** Good results usually follow this injury. The fibula acts in a measure as a splint to the fractured tibia.

**TREATMENT.** The leg should be placed on a pillow for the first twenty-four or forty-eight hours. (Fig. 86). Anterior and posterior felt splints (Fig. 141), or a plaster of Paris dressing, or Keen's splint (Fig. 89) should be used after the swelling abates. Treatment should be continued for five weeks.



**Fractures of the Lower End of the Tibia and Fibula.**—**POTT'S FRACTURE.** *Definition.* Three distinct lines of fracture are present. One at the lower end of the fibula, a half-inch to an inch and one-half from the styloid process, a second, of the internal malleolus of the tibia, and a third, a fracture of the inter-articular surface of the tibia and fibula. (Fig. 143.) Generally speaking, a "Pott's Fracture" is one in which the lower end of the fibula is fractured a half inch to an inch and one-half from the styloid process, and may be accompanied by a fracture of the internal malleolus of the tibia and the inter-articular surface of the lower end of the tibia. A lateral or backward dislocation of the foot always accompanies this fracture, and many cases of reported dislocations in this region have undoubtedly been this form of fracture accompanied by dislocations. (Fig. 145.)

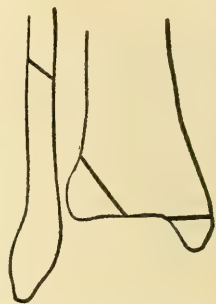


Fig. 143.  
Three Lines of Separation of the Bones in a "Pott's" Fracture.

*Cause.* This fracture is often produced by falls, the patient striking upon the foot while it is inverted or everted. Many cases have occurred simply from a twist taking place in the foot during walking. The common expression of patients who have sustained this injury is that it was produced "by turning the ankle."

*Pathology.* Extensive laceration of the ligaments about the joint occurs, and the upper end of the lower fragment of the fibula inclines toward the tibia (Figs. 146 and 147), or outward, according as the injury was produced; that is,

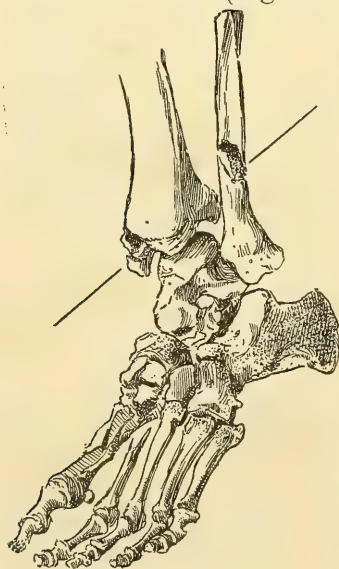


Fig. 144.  
Pathological Anatomical Illustration.—Author's Case.

whether the foot was forcibly everted or inverted. The line of fracture may be transverse or oblique. Backward dislocation is frequently found as well as the lateral variety, and is further increased by the action of the tendo Achillis.

*Symptoms.* Crepitus is always present. The foot is either everted or inverted, the former variety being the most common. The partial dislocation backward, accompanied with the lateral dislocation, will always be noticed. The distance between the malleoli may be greater than normal, especially where the inter-articular connection at



Fig. 145.  
Pott's Fracture.—Author.

the lower end of the tibia and fibula has been destroyed. The astragalus is at times forced directly upward between the malleoli (Fig. 148). This is shown by the increased width of the joint. Pain, swelling and ecchymosis are always observed. Abnormal mobility, loss of function and deformity are invariably present.

*Prognosis.* Good union follows in five weeks, and useful joints should be obtained. Of course this cannot be true of this fracture any more than of other fractures where reduction has never been thoroughly accomplished. The false ankylosis which is apparent when the dressing is first removed is due in many cases to the contracture of the tendo Achillis. The dislocations which accompany this fracture are in many cases left unreduced, and this lack of the reduction of the dislocation explains why this fracture is so often followed by bad results. Ordinarily, good results will follow this injury, but while in many cases slight eversion of the foot remains this eversion is no greater than in many cases of simple sprain where extensive laceration of the ligaments occurs.

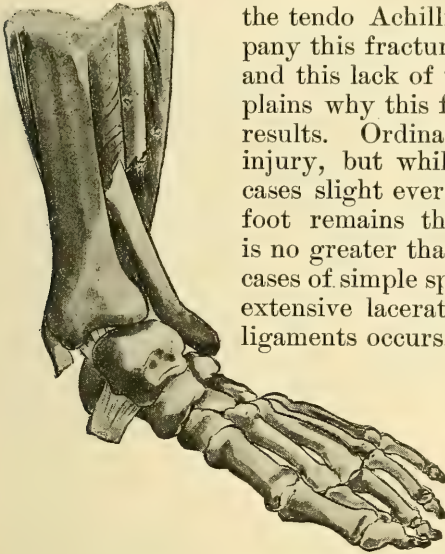


Fig. 146. Pott's Fracture.

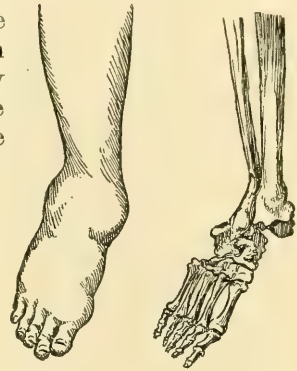
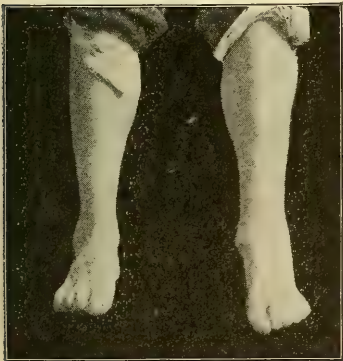


Fig. 147. Pott's Fracture.

*Treatment.* When it is practical early reduction of the dislocation and fracture should be made, and in the majority of cases an anesthetic will be required. Where tremendous swelling has occurred and the soft tissues are more or less contused reduction may be deferred for twenty-four or forty-eight hours, and the leg should be placed during this interval in a soft pillow. (Fig. 86). All fomentations are avoided and when reduction is attempted the use of an anesthetic should be urged upon the patient because only after the patient has been rendered unconscious and relaxed can the proper reduction be carried out. Anterior and posterior felt splints (Fig. 141) moulded to fit the limb, encasing it from the upper part of the leg to the sole of the foot should be applied. This dressing is superior to plaster

Fig. 148.  
Pott's Fracture Showing Increased Width of Foot.—Bishop.

of Paris in the early part of the treatment.

When plaster of Paris is used the dislocations above described constantly incline to recur. The felt splints having been previously moulded to a normal limb naturally help to shape the ankle, and retain it in its normal position. "Dupuytren's Splint" has been in use for years, and, while it apparently has some effect in keeping the lower



Fig. 149. Dupuytren's Splint.

of Paris in the early part of the treatment.



fragment of the fibula in place it has not the slightest influence over the backward dislocation that proves so troublesome in every case (Fig. 149). This splint of Dupuytren may be used in conjunction with the Keen splint, but is rarely useful by itself.

**Fracture of the Patella.**—Fracture of the patella occurs very frequently. Men and women are equally liable to this injury. Nine-tenths of the cases occur in middle adult life, and probably in old age the injury is found second in frequency. It very rarely occurs in children. Simultaneous fracture of both patellæ is infrequent. The fracture of the sound bone during the process of repair of the fracture of the opposite side happens in a large percentage of cases.



Fig. 150. Transverse and Stellate Fractures.

The varieties are transverse and stellate. (Fig. 150.)

**CAUSE.** Violent contraction of the quadriceps extensor muscle is the cause of the fracture in the majority of cases. A few cases occur from direct injury, in which event the fracture is usually stellate. Many of the cases which present a history of direct injury and which are accompanied with a contusion of the soft parts overlying the patella sustain the fracture by muscular contraction just before the knee reaches the ground. The patient usually falls with the foot under him.

**PATHOLOGY.** The periosteum may be only partially torn, thereby holding the fragments comparatively near together. The torn periosteum may dip down between the fragments like a fringe, this being one of the causes of delayed or fibrous union. The contraction

of the quadriceps extensor muscle may elevate the upper fragment from one-half of an inch to five inches. (Figs. 151 and 152.)

**SYMPTOMS.** Crepitus is usually absent except in stellate fractures. Immediately following the injury, before the swelling appears, it is sometimes possible to make out crepitus. Inability on the patient's part to extend the leg upon the thigh is a constant symptom.

Patients are often able to walk backward with the leg in extension. When in bed the heel cannot be raised from the bed except in those rare cases where the periosteum is only slightly torn. These cases are probably produced



Fig. 151.  
Fracture of Patella,  
Side View.



Fig. 152.  
Fracture of Patella,  
Anterior View.

by direct violence rather than by muscular contraction alone. A distinct depression is felt between the fragments and this separation is made more apparent when the leg is slightly flexed. Swelling is sometimes very pronounced but in many cases is slight.

**PROGNOSIS.** Union is always of the fibrous variety except in those cases that are subjected to operative measures. The length of this fibrous



band connecting the fragments varies from one-fourth of an inch to five inches. A fibrous union of one inch or more is often just as useful as one of one-fourth inch. Figs. 153 and 154 show a man who is able to walk with a union of five inches. Both patellæ were fractured in this case and the upper fragments on both sides are at least five inches above the lower ones.

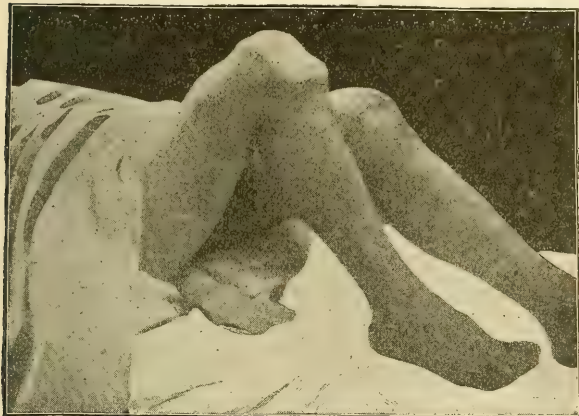


Fig. 153.

Author's Case of the Patella where Patient was able to walk with a Separation of five inches.—Knees Flexed.

patella frequently occurs during the first few weeks after the patient begins to walk, following his confinement in bed. This is occasioned by muscular contraction of the quadriceps extensor muscle of the previously uninjured leg, due to over-development of this muscle and, probably, additional muscular tension to compensate for the somewhat weakened fellow muscle.

**TREATMENT.** Simple transverse fractures may be successfully treated by employing a dressing known as Hamilton's. It is represented in Fig. 155, and consists of a posterior splint made of gum shellac that reaches from the heel to the upper part of the thigh. The gum shellac cloth is first immersed in hot water and accurately moulded to the leg. After it is thoroughly dry it is covered with a muslin bag to which turns of a roller bandage are stitched. The splint is well padded, especially in the popliteal space, and is held firmly to the leg by roller bandages. One should be started from below and applied upward to the knee; a second should be applied from the top of the splint downward toward the knee, thereby seeking to limit the action of the quadriceps extensor muscle. The space surrounding the patella should be left uncovered for a distance of six inches. A third roller which completes the dressing should now be run in the form of a figure-of-eight,

#### RE-FRACTURE.

When the fracture takes place a second time the chances for good fibrous union are bad and the case should be operated at once. Many people are able to walk after this second injury, though the usefulness of the leg is decidedly impaired.

#### Fracture of the Opposite Patella.—

Fracture of the second

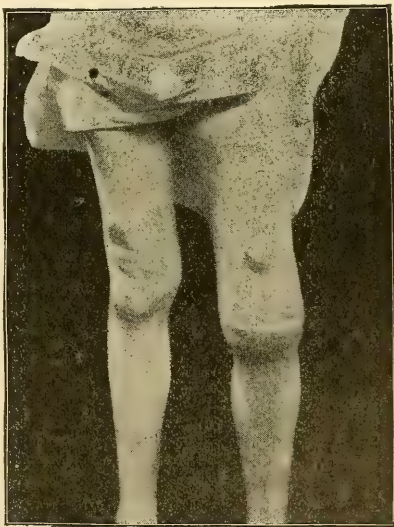


Fig. 154. Same Leg Extended.

which entirely envelops the knee joint. These turns of the roller are sewed to the muslin, previously placed over this posterior splint. The third roller, forming the figure-of-eight, should be changed daily and tightened when necessary. The leg is elevated on a pillow and the shoulders are also well raised from the bed.

Systematic massage of the leg should be given from the beginning of the treatment, thereby retaining the tonicity of the quadriceps extensor muscle. The knee should not be bent until the treatment has been continued for eight weeks, at the end of which time passive motion should be begun. The patient may be allowed to walk after two months, but not without the splint or a suitable flexible knee-splint for at least four weeks more.

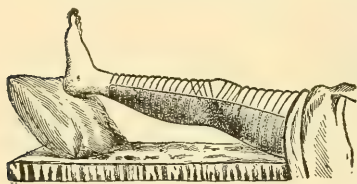


Fig. 155. Hamilton's Dressing for Fracture of Patella.

The use of a straight posterior wooden splint or Hamilton's inclined-plane splint, with alternating straps of rubber adhesive plaster above and below the patella, should not be resorted to in place of the dressing above described; for the irritation caused by the plaster is so great at times that all treatment has to be abandoned. The pain produced is excruciating and the pressure produced by the straps shuts off a portion of the circulation about the patella; necrosis has even been known to follow.

Malgaigne's and Levis' hooks are never used at the present time. Before the day of aseptic surgery they were used occasionally, pyemia and loss of limb, or even life, following such use.

*Operative Treatment.* Since asepsis has been introduced into surgical practice the knee-joint has been often opened and "wiring" the frag-



Fig. 156. Operation by Sub-Cutaneous Ligature.

ments of a fractured patella may now be done with comparative safety by observing the strictest aseptic principles. Although little danger may be apprehended from operations that open the knee-joint, when the laws of asepsis are observed, still the surgeon who cannot be absolutely certain of his ability to carry out these rules has not the right to endanger loss of limb, or even life, by these operations.

There are some forms of fracture, as compound, and a variety in which the fractured surfaces face directly upward, which should be at once "wired." The incision may be either transverse or longitudinal and by one sweep of the knife the soft tissues are divided. If the injury is a



recent one the drill holes through the fractured ends are made at once, otherwise the fractured surfaces must be first freshened by means of the saw.

The holes should be drilled from above downward, should be started one-fourth of an inch from the edge and made obliquely downward, emerging on the fractured surfaces immediately above the posterior margin of the patella.

Two or three sutures are sufficient, and silver wire or kangaroo tendon is the material used for sutures.

If silver wire is used it is best to turn the ends of the wire down between the fractured surfaces. Kangaroo tendon answers the purpose admirably and should be used in preference to wire.

The periosteal fringe is trimmed off before tying the sutures. The wound is closed by silk-worm sutures, and a posterior felt or plaster of Paris splint applied. After five weeks have passed no harm will result by allowing the patient to walk.

The knee should be flexed slightly at the end of six weeks, and daily passive motion of the knee joint should begin at this period.

*Operation by Sub-Cutaneous Ligature.* This is a new method but should be done under the same precautions for "wiring" as in the operation just described. A surgeon who selects this operation in preference to the old method because it is less dangerous certainly makes an error. He who is afraid to undertake the operation of suturing the fragments, and is not confident that all the aseptic precautions can be observed, should not undertake the method by "sub-cutaneous ligature." Cocaine may be used for this operation, but it is much better to place the patient under the influence of a general anesthetic.

Four small lateral incisions are made

(Fig. 156), two above and two below the patella. Great care should be taken that the ligature does not enter the joint. A long straight needle armed with a stout ligature of pedical silk is introduced through the tendon of the "quadriceps extensor muscle from A to B, (Fig. 156), and then made to re-enter the point of exit, B, and to pass directly downward at right angles to a line parallel to the ligature from A to B, leaving the body at the point C. The needle is re-introduced at C and passed through the ligamentum patellæ, and brought out at D. The needle is entered at D and passed upward and out at A, the point of entrance. The fragments are now approximated as nearly as possible by tenaculæ, and then the ligature is tightened and tied. The ends of the ligature are cut off short and are dropped back into the the wound and the four incisions closed by silk sutures. Great tension on the ligature should be carefully avoided, and only moderate force should be brought to bear in tying the ligature even though the fractured surfaces may not be in perfect contact. Even if a little separation exists good fibrous union will follow. The leg should be encased in plaster of Paris, and at the



Fig. 157. Sub-cutaneous Ligature used on account of smallness of upper fragment.—Bishop.



end of six weeks passive motion of the knee may be begun. There is little danger in allowing the patient to limp about the room with the leg in extension after the fourth week. At the end of the treatment the ligature is removed if there are any symptoms which show that the ligature is a source of irritation. Fig. 157 represents a case upon which this method was used and this operation was selected because the line of separation was very high.

## CHAPTER VIII.

### FRACTURE OF THE FEMUR.

**Above the Condyles.**—**CAUSE.** Falls upon the knees or feet, usually from a great height, are the cause of this fracture.

**PATHOLOGY.** The upper fragment is found in front of the lower one. The fracture is usually oblique and the line runs from behind forward and downward. Injury to the popliteal vessels may be anticipated. (Fig. 158.)

**SYMPTOMS.** Shortening, crepitus, and abnormal mobility are always easily detected, and make the diagnosis easy.

**PROGNOSIS.** Some shortening always remains, but it is not enough to cause a limp. However, in many cases the use of the limb is limited, and extreme flexion is impossible. Good union is the usual result. Slight eversion of the toes is likely to remain. The amount of callus is always great, and crooked legs are very apt to follow, even where the most intelligent treatment has been employed.

**TREATMENT.** Buck's modified extension combined with a long side splint is the best dressing (Fig. 95). Plaster of Paris should be used during the last four or five weeks of the treatment,

and in some cases it is suitable as a dressing from the beginning. Treatment should be carried out for at least ten weeks.

**Fracture of Either Condyle.**—**CAUSE.** Produced by injuries, such as a direct blow or a twist of the knee.

**PATHOLOGY.** The condyle is found completely detached and violent contraction of the neighboring muscles is observed.

**SYMPTOMS.** Abnormal lateral motion is present and a movable detached condyle is felt. Increased width of joint and crepitus are constant symptoms.

**PROGNOSIS.** Good limbs follow this injury, and little fear of serious complication or even ankylosis need be entertained.

**TREATMENT.** The limb is immobilized in a straight position. Plaster of Paris dressing should be applied as soon as practicable.



Fig. 158.  
Fracture of Femur above  
Condyles.



Fig. 159.  
Fracture of Femur, Middle  
Third.

**Fracture Between the Condyles.**—**CAUSE.** Falls or blows upon the feet or knee produce it. The force of the injury is always great.

**PATHOLOGY.** The line of separation runs into the joint, and injury to the popliteal structures may occur.

**SYMPTOMS.** The joint is abnormally wide and great lateral motion is always present. Severe pain and swelling are prominent symptoms. Crepitus may not be detected.

**PROGNOSIS.** Ankylosis is very apt to follow, and the injury to the knee joint may be so great that the limb may have to be sacrificed. Some loss of power to the leg is certain to follow this accident.

**TREATMENT.** Immobilization in a position slightly flexed. Slight extension (by Buck's modified extension plan, Fig. 95) for a limited time may be used. A form of suspension apparatus, Hodgen's or Smith's, may be used. Plaster of Paris constitutes the best dressing as soon as the acute swelling abates.

**Fracture of the Shaft.**—**VARIETIES.** The middle, upper and lower thirds of the femur may be fractured.

**CAUSE.** The femur is broken by direct injury applied over the seat of the fracture.

**PATHOLOGY.** In the middle variety the fracture may be oblique or transverse. The lower end of the upper fragment projects forward. (Fig. 159.)

In the upper variety the fracture is usually oblique, and the action of the muscles draws the upper fragment forward and outward. (Fig. 161.)

In the lower variety the obliquity is not so marked as it is in the upper third.

**SYMPTOMS.** Marked shortening, crepitus, abnormal mobility and eversion or inversion of the foot are almost invariably observed.

**PROGNOSIS.** Shortening follows every fracture of the femur, and even when it is as great as one inch the patients walk with little limp. Non-union is rare and when it does occur it is likely to be in cases of re-fracture.

**TREATMENT.** The best dressing is "Buck's modified" with a long side splint, the same as advocated for fractures of the neck. Smith's and Hodgen's are not in general use at the present time, and, as with plaster of Paris dressings, shortening must remain uninfluenced by these



Fig. 160.  
Fracture of Femur, Upper Third.



Fig. 161.  
Fracture of Femur, Upper Third.—Bishop.



splints. When plaster of Paris is used it should be applied so as to envelop the leg as well as the thigh. The apparatus shown in Fig. 162 is of value in applying this dressing. Plaster of Paris dressings do not

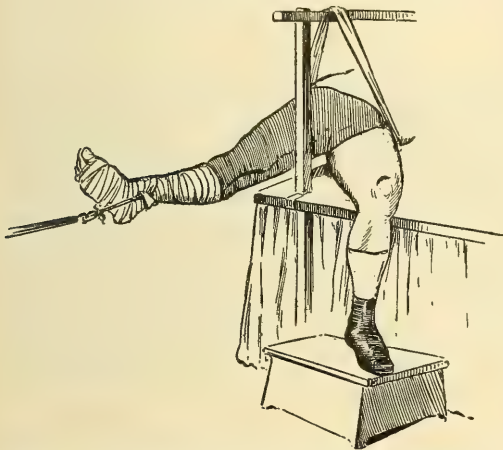


Fig. 162. Position during application of Plaster of Paris Dressing.

have the slightest influence over shortening, which invariably accompanies fractures of the femur.

For the treatment of fractures of the femur in young subjects Hamilton's splint should be used. (Fig. 164.)

It is well to apply over the seat of fracture a dressing composed of three or four small splints, as represented in Fig. 166. These pieces should be two to three inches wide and six to ten inches long. They may be held securely together by bands of adhesive plaster

instead of the straps or bands as shown.

**Fracture of the Upper End.** — **VARIETIES.** Fracture of the small part of the neck—known as intra-capsular—of the base of the neck (Fig. 163)—extra-capsular—fracture through the trochanters, and fracture of the trochanter major. The classification adopted by Stimpson—calling all such fractures “Fractures of the small part of the neck,” in place of the old variety, “intra-capsular,” and fractures of the base of the neck, “Fractures at the base of the Neck,” in place of “extra-capsular”—is the best. The classification of intra- and extra-capsular fracture is imperfect, because in many cases the line of fracture runs partly within and partly without the capsule.

**CAUSE.** These fractures are produced by falls where the patient

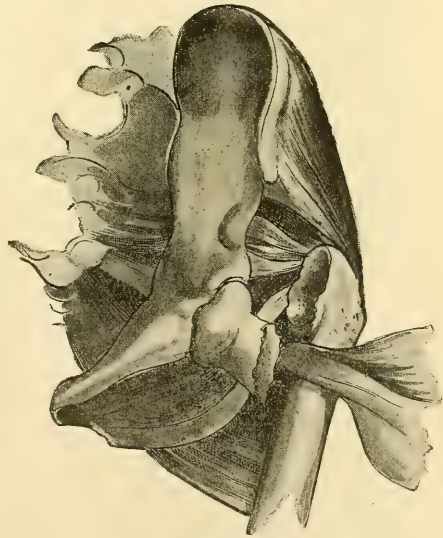


Fig. 163.  
Fracture at Base of Neck of Femur.

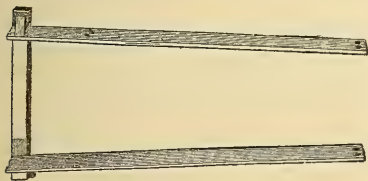


Fig. 164.  
Hamilton's Splint for Children.

strikes upon the feet or hips, or by direct blows received over the region of the trochanter.

**PATHOLOGY.** In fracture of the small part of the neck the line of fracture may lie partly within and partly without the capsule, or entirely within the capsule. The ligamentum teres is the only source of nourishment to the

head of the bone after fracture, and in many cases necrosis of the head follows.



Fig. 165. Fracture of Trochanter Major.

**BASE OF THE NECK.** The line of fracture runs for the greater part directly through the bone outside the capsule, the upper fragment is freely supplied with blood and necrosis of it is exceedingly rare. (Fig. 163.)

**FRACTURE THROUGH THE TROCHANTER.** The line of separation of the fracture is far away from the capsular line and many times a portion of the trochanter may be observed to be attached to the upper fragment.

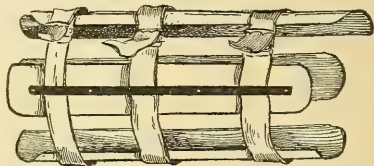


Fig. 166.  
Splints for Fracture of Femur.

#### SYMPTOMS.

- Small Part of the Neck:*
1. It usually occurs in old women. The force of the injury is slight.  
  
Shortening is very slight at first, but is apparent after a few days or a week. The measurements should be made from the anterior superior spine of the ilium and the great trochanter.  
Crepitus is absent.  
Pain, swelling and ecchymosis are not great.  
The trochanter moves with the limb when it is rotated.  
The foot is everted.  
Some loss of use of the limb or non-union will result.

- Through the Trochanter.*
3. It occurs in males.  
The force of the injury is extreme and is usually received over the region of the trochanter.  
Shortening is noticeable from the beginning.  
Crepitus is present.  
Pain, swelling and ecchymosis appear early, and the leg is usually held flexed upon the thigh. (Fig. 167.)  
The entire trochanter does not move when the limb is rotated unless the fracture be of the impacted variety.  
The foot is everted.  
Union is usually prompt and although the limb is shorter than before the injury the patient has good use of it.

- Base of the Neck.*
2. This occurs in adult males.  
The force of the injury is severe and is received over the trochanter.  
Shortening is marked from the beginning.  
  
Crepitus is present.  
Pain, swelling and ecchymosis promptly appear.  
The trochanter moves when the limb is rotated.  
The foot is everted.  
Union is usually prompt, but some shortening follows and the patient usually limps.

- Of the Great Trochanter Only.*
4. It occurs usually in males.  
The cause is direct blows received over the region of the trochanter.  
  
Shortening is never present.  
  
Crepitus may be found usually.  
The pain and swelling are slight, but more or less ecchymosis takes place.  
The trochanter is felt as a movable body in its natural position, or a little higher, and does not move when the limb is rotated.  
The foot is not everted.  
Good use of the leg follows this fracture.

**FRACTURE OF THE TROCHANTER MAJOR.** The detached trochanter is found completely separated from the femur. (Fig. 165.)

**PROGNOSIS.** *Small Part of the Neck.* The prognosis is unfavorable and when union does occur it is always fibrous. Occurring as it does in old people, death from exhaustion frequently takes place. Patients



Fig. 167.  
Fracture through the Trochanter—Bishop.

who have suffered this injury are often bedridden for the rest of their lives, as non-union is the usual result.

*Base of the Neck, and Through the Trochanter.* Bony union usually takes place. Shortening always follows, but the patients are able to walk, although many of them have a decided "halt" in their gait. Figure 169 represents the amount of shortening which almost invariably takes place after this injury.

*Of the Trochanter Major Only.* Only fibrous union takes place, but no embarrassment of the use of the hip follows.

**TREATMENT.** Attention to the general health of the patient should be closely watched, especially in the first variety, and in this form it is often better to discard all dressing and simply nourish and build up the general health of the individual than to attempt to secure union.

The lives of old people are often sacrificed by the overzealous efforts of the surgeon to obtain union by employing cumbersome dressings and splints and neglecting to build up the general health of the individual. Plaster of Paris is never suitable as a dressing for these fractures.

The splints of Smith and Hodggen, and the inclined planes are all useless. A modified Buck's extension, combined with a long side splint that reaches from the axilla to and below the foot, constitutes the best dressing at command. For a description of this dressing see page 432, Fig. 95.

The treatment for fracture of the trochanter alone is best carried out by immobilizing the hip and leg by a long side splint. The treatment should be kept up for at least ten weeks.



Fig. 168.  
Showing Elevation of Trochanter of Fractured Bone.

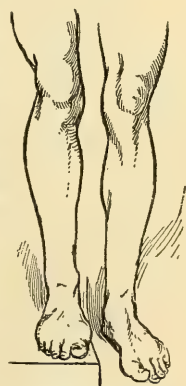


Fig. 169.  
Showing Shortening after fracture of Thigh.



## CHAPTER IX.

### FRACTURES OF THE PELVIS.

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**Os Innominata.**—The os innominata may be broken in any one of its three divisions. The fracture is caused by direct violence. The force of the injury is severe and usually of a crushing nature, as a wagon passing over the pelvis. Falls upon curbstones or car-tracks have been known to produce fracture of the anterior superior spine and crest of the ilium. Kicks from a horse have also produced this injury.

**PATHOLOGY.** Separation at the symphysis may take place and no fracture at any portion be found. The line of fracture may involve two or more of the bones making up the pelvis.

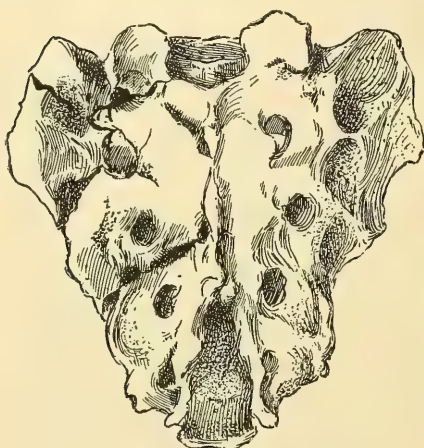


Fig. 170. Post-Mortem Specimen.

**SYMPTOMS.** Crepitus is difficult to elicit, but while turning the patient in bed it may perhaps be detected. Swelling comes on early and is extreme. When a separation at the symphysis occurs it may be possible to feel the space between the two pubic bones.

**PROGNOSIS.** These injuries very often involve serious complications, as wounds of the viscera. Death frequently results from shock, and if the patient recovers some permanent paralysis may persist. The bladder is especially subject to injury and the organs of generation are at times involved. Many of these patients must be catheterized for days or weeks after they have been injured.

**TREATMENT.** Absolute rest in bed is necessary. A roller bandage or a broad band of adhesive plaster should be passed around the pelvis, in this way immobilizing it as much as possible.

**Sacrum.**—**CAUSE.** The sacrum is rarely fractured, but falls from a height, striking upon the back, railroad accidents and injuries of a crushing nature, as are produced by wagons running over the patient, may result in this disaster. (Fig. 170.)

**PATHOLOGY.** Injury to the nerves which pass through the sacrum is always noticed. Paralysis of the limbs and the bladder may be accounted for by injury to these nerves.

**SYMPTOMS.** Crepitus may be elicited when the fracture is comminuted, especially in thin people, by placing the hand over the sacrum and turning the patient in the bed.

**PROGNOSIS.** The prognosis is grave. Important nerves are injured, permanent paralysis of the bladder or the rectum may be anticipated, and death often relieves these patients from a life of permanent invalidism.

**TREATMENT.** Absolute rest in bed is necessary, and immobilization is partially accomplished by a broad band of adhesive plaster or a roller bandage placed around the pelvis. Plaster of Paris may be useful in some cases. Water beds are often grateful to these patients, and extension to the spine always relieves the pain.

**Coccyx.**—**CAUSE.** Women often sustain this injury during labor; base-ball players and foot-ball players are also subject to it. Sudden falls and striking upon a hard object, as the arms of a chair, have been known to cause this injury.

**PATHOLOGY.** Instead of the bone being fractured in its continuity it is often separated at its articulation with the sacrum. The rectum has been injured by a broken coccyx.

**SYMPTOMS.** By passing the finger into the rectum the coccyx in its abnormal position may be located. Severe neuralgic pains (coccydynia) do not always appear early, but after the first acute symptoms have subsided the true neuralgic pains manifest themselves. The patients are unable to sit squarely upon a chair. Some irregularity of the action of the bowels will be noticed.

**PROGNOSIS.** In many cases the patient's health is not impaired, but where the coccyx is widely deflected from its normal position an operation is the only means by which we may expect to effect a cure.

**TREATMENT.** If after a number of weeks these symptoms all remain removal of the fractured coccyx should be attempted. This operation is free from danger and should be done under strict aseptic precautions.

**OPERATION.** The patient is placed upon his chest with the hips well elevated. An incision three inches long is now made parallel to the spine, directly over the coccyx. This incision is carried through skin and fat, directly down to the periosteum, which is divided, and by means of a periosteotome the covering of the bone is deflected to one side. The bleeding will be more or less profuse but not dangerous, and as a rule no large vessels will be severed. The coccyx, having been exposed and bared of its periosteum, is now amputated at the line of fracture by means of a pair of bone forceps. No nerve trunks of any importance will be cut. However, in many cases retention of the urine will last for days or even weeks after the operation. The cut surfaces of the periosteum are stitched together and the wound closed by deep and superficial sutures of silk-worm gut, sheep-gut or black silk.

## CHAPTER X.

### DISLOCATIONS.—GENERAL CONSIDERATIONS.

**Definition.**—A dislocation is the separation of the articular surfaces of two or more bones which enter into the formation of any joint.

A simple dislocation is one which is not complicated by extensive injury of the soft tissues or which is not accompanied with a fracture.

A compound dislocation is one in which there is direct communication between the atmosphere and the seat of the dislocation.

A complicated dislocation is one which is accompanied with an injury to the soft tissues or to important viscera.

A complete dislocation is one in which the articular surfaces of bones which enter into the formation of any joint are not in contact.

An incomplete dislocation is one in which some portions of the articulating joint surfaces of the bones which enter into the formation of the joint are still in contact.

Dislocations may be double (both hips simultaneously), (Fig. 171), or multiple, when two or more bones, not corresponding ones in two extremities, are dislocated.

Dislocations are also known as traumatic, spontaneous, and congenital.

**Causes.**—**TRAUMATIC.** These dislocations occur most frequently in middle adult life and are generally produced by external violence, rarely by muscular contraction alone.

**SPONTANEOUS.** Some pathological change may take place in a joint or in a capsule or in the ligaments about the joint, and this pathological alteration, when co-operative with external violence or muscular action, may be the cause of certain dislocations.

**CONGENITAL.** The congenital deformity of the bones making up any joint, as a short neck of the femur or a shallow acetabulum, may be the cause of this form of dislocation. Extreme laxity of the ligaments in or about joints is frequently observed to be the cause of congenital dislocations.

**Pathology.**—**TRAUMATIC VARIETY.** Rupture of portions of the ligaments and of the capsule in the vicinity of joints must occur in all dislocations, but the fact that many important ligaments are not entirely torn explains the existence of certain characteristic symptoms which are present in dislocated limbs. The "Y" ligament largely influences the position of the leg in dislocations of the hip.



Fig. 171. Backward dislocation of both Hips.—Fitzgerald.



**SPONTANEOUS VARIETY.** When actual disease is present in a joint and a luxation occurs the dislocation is possible because the joint structures are so changed that either the unopposed weight of the limb or the contraction of the muscles is sufficient to produce the deformity.

**CONGENITAL VARIETY.** The actual difference between the condition of the ligaments, etc., of this variety and the spontaneous form is that the changes noted in the spontaneous variety are produced by disease, while in the congenital form, although almost the same variations from the normal take place, the change more closely resembles an arrest of development.

**Symptoms.**—**TRAUMATIC.** Shortening is a symptom of most varieties. All dislocations are characterized by an absence of crepitus, by abnormal immobility and by the fact that when the dislocations are reduced the deformity does not incline to recur. Pain, swelling and ecchymosis are attending symptoms. Paralysis and interference with the circulation are frequently observed.

**SPONTANEOUS.** Shortening is present. Since this form of dislocation is due primarily to actual pathological changes many of the prominent symptoms of dislocation so ordinarily understood are absent in this variety. During serious sickness, especially in fevers and rheumatic illness, spontaneous dislocations take place gradually and unobservedly. However, the unnatural position which the limb assumes will in many cases be the same as in the acquired or traumatic variety; but pain, swelling and ecchymosis will not be found to any degree.

**CONGENITAL.** Shortening will be noticed. The symptoms found in all dislocations of the congenital variety differ from those of either of the other two forms. Swelling and ecchymosis will never be found unless through accident the dislocation remains out for a longer period than is ordinarily allowed. Pain is often a prominent symptom, but to a less degree than in the traumatic variety. Preternatural immobility is characteristic of these dislocations, and the positions which the limbs assume are quite similar to those of the traumatic variety. It may be said that there is always noticed a little more freedom of motion in cases of congenital dislocations than in the traumatic variety.

**Prognosis.**—**TRAUMATIC.** When acquired dislocations are immediately recognized and the reduction of the dislocation has been early and prompt, good, useful joints always follow. In many cases where important nerves or blood vessels have been pressed upon or stretched, temporary or permanent paralysis of certain groups of muscles or interference with the circulation of the blood may result.

**SPONTANEOUS.** From the changes which take place in the joints in this variety of dislocation it is easy to understand that loss of function or permanent deformity will always exist.

**CONGENITAL.** Congenital dislocations may often be permanently prevented in children when they are observed early. It is accomplished by the employment of some kind of apparatus which will prevent the recurrence of the deformity. Children should not be encouraged to perform any action which will produce a dislocation of any joint, when it is known that the child suffers from this lax condition of the ligaments and capsular structures. In the case of Fitzgerald, whose congenital dislocations are illustrated in this work, this unnatural state of the ligaments of

the joints had been brought about mostly by exercise and patient manipulation covering a period of twenty-five years. As a child this man was noted for his loose-jointedness, as shown in Figs. 171, 190, 191, 193, 195 and 196.

**Treatment.**—**TRAUMATIC.** This form of dislocation should be reduced at the earliest possible moment, as delay of even a few hours often means failure. The principal obstacles to be overcome in all dislocations are the contraction of the muscles and the stretched state of the untorn ligaments and capsule. It is necessary, in order that the minimum amount of damage be produced in attempts at reduction, to relax the muscular structures and relieve the tension of the ligament. The general expression, therefore, to “move the limb in the direction of least resistance” is a correct one. Forcible opposition to the contracted muscles and stretched ligamentous fibres can only result in injury. The methods of manipulation which have as their scientific basis this same relaxation above mentioned should be preferred to all other methods of reduction. Repeated trials at reduction should be given by this method before the more severe and unscientific modes by traction by means of pulleys are instituted.

To reduce dislocations by manipulation requires gentleness and a thorough anatomical knowledge of the actions of muscles or groups of muscles and ligaments in the neighborhood of the joints under consideration. The patient should not be anesthetized at the first trial, because this method, that of manipulation, cannot be typically carried out when the patient is unconscious. The rigidity of the muscles and ligaments about the joints found in every dislocation will not entirely disappear even when anesthetics are employed, but to a greater or less extent the spasmodic contraction of the muscles will disappear when the patient is unconscious. There is always danger of doing harm to important deep structures when anesthetics are employed, though it is impossible in many cases to reduce dislocations, especially those about the hip, without their use. Therefore, great care should be exercised when attempting to reduce dislocations in unconscious patients, otherwise irreparable damage may be inflicted.

The use of pulleys may be necessary when more scientific measures have failed, and when traction is thus used it is supposed that the force used should not be great enough to rupture muscles and ligaments, but should be sufficient to reduce the dislocation by forcibly dragging the bones into their normal position after the muscles have been fatigued by long continued traction.

There is always danger of the soft tissues, especially portions of torn capsules, becoming interposed between the articular surfaces of bones which enter into the formation of joints when dislocations are reduced, whether the methods by manipulation or traction are employed. The ends of bones so dislocated will often be button-holed by torn capsules, or by the splinting of ligaments or tendons, and when this occurs it will forever prevent reduction. When this takes place in the small joints, as in the fingers, an operation may be made by cutting down upon the joint, and removing the obstruction.

**SPONTANEOUS VARIETY.** Reduction of this variety of dislocation is ordinarily very easy and traction only is necessary. To prevent recur-

rence, however, all treatment should be directed to the disease of the joints and peri-articular structures which has caused the pathological change. The paralysis of certain groups of muscles may be relieved by treatment.

**CONGENITAL VARIETY.** These dislocations must be reduced by manipulation in much the same manner as recommended for the traumatic variety. On account of the laxity of the ligaments, and the absence of swelling and pain, traction in the long axis of the bone will often alone be sufficient to effect reduction.

**Dislocations Which Take Place in Utero.**—These dislocations belong to the traumatic variety and are in no sense congenital. They are produced either by the contraction of the uterus or by the accoucheur at the time of birth.

**Old Unreduced Dislocations.**—Each individual case may show some peculiarity of its own. It is often less difficult to reduce a dislocation of long standing, where failure to primarily reduce the dislocation was due to an inability to obtain surgical attendance rather than to repeated and unsuccessful trials. In children with dislocations extensive adhesions which are firm and unyielding form early, and in many instances prevent reduction even at an early date. Again, when the dislocated head of a bone has been in an abnormal position for any length of time the structure of the head of the bone will be altered, or a new socket will be formed for the head of the bone in its abnormal position. The old fossa which nature intended to receive the head of any bone will be found in every case of old unreduced dislocations, filled with a new fibrous and partly organized material. When the head of the bone is returned to its normal position in these cases it constantly inclines to leave its position and return to its new or abnormal location.

No definite rule can be laid down for the treatment of these cases, and if after moderate manipulation and the use of traction it is found that the dislocation is not changed the propriety of cutting down and opening the joint is questionable. If fairly good, useful joints are found, it is good judgment to allow these displaced bones to remain in their abnormal positions. Much good, however, often comes from forcibly breaking up the adhesions, which have occurred after the limb and joint have been kept at rest during a period covering, perhaps, many months. After these adhesions have been broken up the patient should be instructed to use the injured member or joint, and it will be gratifying to the surgeon to find that the range of motion will increase materially.



## CHAPTER XI.

### DISLOCATIONS OF HAND AND FORE-ARM.

**Dislocation of the Phalanges.**—**VARIETIES.** The two common varieties are backward and forward.

**CAUSE.** Ball-playing, blows, and falls are among the usual causes.



Fig. 172. Prominence of head of Phalanx.

**PATHOLOGY.** The ligaments rupture and in some cases a ligament splits and securely holds the head of the phalanx.

**SYMPTOMS.** There is no difficulty in diagnosing these injuries on account of the small amount of soft tissue in these regions. The prominence of the dislocated head of the phalanx may always be made out. (Fig. 172).

**PROGNOSIS.** Useful fingers should always result, but large knuckles and deformed digits follow the injury.

**TREATMENT.** Reduction is made by extension or dorsal flexion followed by flexion while the extension is employed. The Indian puzzle (Fig. 174), the clovehitch (Fig. 173), and several mechanical devices (Figs. 175 and 176) may be useful in effecting reduction.

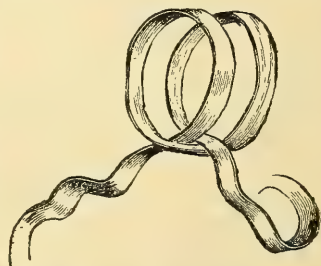


Fig. 173. Clove-hitch.

**Dislocation of the Thumb and Finger.**—**METACARPO-PHALANGEAL VARIETIES.** Incomplete, complete and complex.

**CAUSE.** Falls upon the hand, causing the thumb or fingers to be dorsally flexed.

**PATHOLOGY.** In the thumb the two heads of the brevis policis muscle may button-hole the head of the metacarpal bone, or, again, ligamentous structures may be interposed between the bone ends.

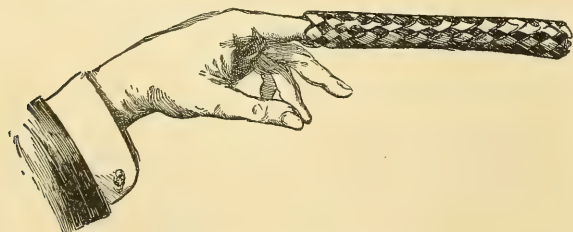


Fig. 174. Indian Puzzle.

**SYMPTOMS.** The second phalanx is flexed upon the first, and the first is inclined backward. The complex variety is produced by changing the complete, which is caused by forced dorsal flexion, into the complex by the production of extension

before the ends of the bones are approximated by pressure, downward and forward.

**TREATMENT.** The complex change is into the complete variety by dorsal flexion. Pressure downward and forward upon the head of the

dislocated bone, combined with extension and flexion, will accomplish the reduction provided no soft tissue is held between the bone ends. Operative measures may be necessary when soft tissue becomes lodged between the bone ends, preventing reduction.

**Dislocation of the Metacarpal Bones.**—**SPECIAL POINTS.** This injury is rare. The varieties are backward and forward. The common causes are falls upon the hands, objects driven with force against the ends

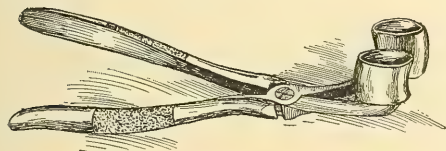


Fig. 175. Device for Effecting Reduction.

of the fingers, etc. The pathology consists of extensive laceration of the ligaments. The end of the dislocated bone may be felt in its abnormal position and the thumb or finger will be found perfectly straight. The prognosis is good; some deformity usually remains but good use of the hand follows. The treatment consists usually of reduction by extension with direct pressure over the dislocated end of the bone. Straight anterior and posterior splints should be worn for two weeks.

**Dislocation of the Carpal Bones.**—This is backward and forward. Gunshot and compound fractures are often accompanied by a dislocation of one or more of the carpal bones. The backward variety is the most common.

Falls upon the hands and injuries that squeeze the wrist and at the same time rotate or twist it are common causes. It is accompanied by extensive laceration of the ligaments which bind the carpal bones together.

The distinctive symptom is prominence of the dislocated bone in its unnatural position. The “lump” may usually be felt on the back of the hand, disappearing upon pressure. Pain and swelling are attending symptoms.

Good use of the wrist usually follows this injury, even though the dislocation is compound. Great deformity may follow, at times such deformity seriously interfering with the usefulness of the wrist.

**TREATMENT.** Pressure over the dislocated bone will reduce the deformity and a dorsal splint should be used for three weeks. If the injury is compound it is often better to pick out the loose pieces of bone.



Fig. 176. Device for Effecting Reduction.

**Dislocations of the Wrist Backward and Forward.**—These forms differ from each other simply in the direction in which the bones are displaced and the cause, pathology, symptoms, prognosis and treatment are essentially the same.

They are caused by falls upon the palm or the back of the hand, and are attended by rupture of the anterior, posterior and lateral ligaments. At times serious injury to the blood vessels and nerves will be noticed.

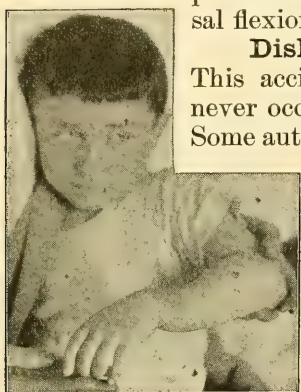
**SYMPTOMS IN THE BACKWARD VARIETY.** The symptoms are the dislocated carpal bones which cause a deformity resembling the silver fork deformity (Fig. 177) of a fracture of the lower end of the radius, but it may be diagnosed from such a fracture by examining the styloid processes of the ulna and radius. In the fracture the styloid process of the radius

lies on a level with or even higher than that of the ulna. In the dislocation of the wrist backward, the relative normal heights of the styloid processes of the bones of the forearm are not changed. Crepitus is absent.

In the forward variety the prominence of the carpal bones at the palmar aspect of the hand will be the leading differentiating symptoms between the fracture and the dislocation of the wrist backward. The deformity does not tend to recur after reduction, as is the case in fracture of the lower end of the radius.

**PROGNOSIS.** The swelling following the reduction is often extensive, but if the injury is not compound, and if unaccompanied with a fracture, good use of the wrist should be obtained.

**TREATMENT.** Reduction by extension combined with pressure applied directly over the dislocated bones. Flexion or dorsal flexion may be used to advantage.



**Fig. 177. Dislocation of Wrist Backward.**—Neilson.

#### **Dislocation of the Lower End of the Ulna.**—

This accident is rare and many surgeons claim that it never occurs unaccompanied by a fracture of the radius. Some authors describe varieties as backward and forward and give the cause as injuries of a twisting nature received by lifting weights from the floor by the hand. The forward variety is usually produced by forced supination. It is said to cause rupture of the internal lateral ligament and the fibro-cartilaginous ligament. The lower extremity of the bone may be forward or backward. There is prominence of the styloid process found either on the anterior or posterior side of the wrist.

**TREATMENT.** Reduction by extension and counter-extension combined with supination of the hand and direct pressure applied over the styloid process.

An anterior and posterior straight splint or a plaster of Paris dressing should be worn for ten days.

**Dislocation of the Ulna, Upper End.**—The only variety that ever exists is the one known as backward. It is caused by falls upon the elbow or hand.

**PATHOLOGY.** There is great doubt in the minds of surgeons whether this dislocation ever occurs uncomplicated with dislocation of the radius. Rupture of the ligaments must be extensive. The dislocation may be complicated by a fracture of the coronoid process of the ulna, fracture of the upper end of the radius, or fracture of either condyle of the humerus.

**SYMPTOMS.** The hand is always found in pronation, the fore-arm falls to the ulnar side, the olecranon is prominent, and the elbow cannot be flexed beyond a right angle. The result should be good unless complicated by a fracture, in which case great loss of function of the elbow may result.

**TREATMENT.** Reduction by extension and counter-extension, while the arm is held in a flexed position, the counter-extension being then made from the anterior surface of the lower end of the humerus. The arm should be dressed at a right angle, using a right-angled felt or plaster of



Paris splint, and the hand should be carried in a sling for at least two weeks.

**Dislocation of the Head of the Radius Forward.**—This is the most frequent variety of dislocation of the head of the radius, and is caused by falls upon the hand or elbow, or by direct injury upon the side of the fore-arm. The head of the radius is carried forward and by subsequent forced flexion it can be readily made to occupy a position external to the humerus.

**SYMPTOMS.** The head of the radius is felt in the bend of the elbow, and during supination and pronation of the hand the head of this bone is found to rotate with difficulty in its new position. The antero-posterior diameter of the joint will be increased. The hand is held in a position midway between supination and pronation and cannot be flexed beyond a right angle.

**PROGNOSIS.** This should be guarded, as it is impossible in some cases to reduce this dislocation; and if the annular ligament has been ruptured the torn fragments of the ligament may act as an obstacle to reduction by becoming interposed between the head of the bone and its articular surface with the humerus.

**TREATMENT.** The object is to reduce the dislocation by extension and counter-extension while the fore-arm is partially flexed upon the arm, the arm being always found in a partially flexed position. While extension and counter-extension are being made the head of the bone is pressed backward and supination and pronation are produced. The dressing should be such that will keep the arm confined for two weeks in a flexed position. At the end of two or three weeks the arm may be taken out of the sling and right angle splint, and gradually straightened. The powerful action of the biceps muscle will reproduce this dislocation if the arm is treated in the straight position from the beginning.

**Backward Dislocation of the Radius.**—This is a rare injury. It is caused, as a rule, by falls upon the hand or elbow or direct injury to the inner surface of the elbow, in which the annular ligament is invariably torn when this dislocation occurs. The cup-shaped head of the radius can be made out on the posterior aspect of the elbow. The arm is found in a flexed position and is pronated.

**PROGNOSIS.** This is good if reduction can be accomplished, as no further trouble with the elbow may be expected. When the annular ligament is extensively torn it may be impossible to reduce the dislocation or to prevent recurrence.

**TREATMENT.** Reduction is best accomplished by extension and counter-extension while the arm is either flexed or semi-flexed. forcible supination of the hand is made while extension is being produced. Pressure forward directly over the head of the radius may be useful. The arm should be dressed at a right angle and carried in a sling for at least two weeks. Extension of the fore-arm upon the arm should not be permitted until after three weeks.

**Outward Dislocation of the Radius.**—This is caused by falls upon the hand or elbow. The injury usually occurs as a secondary dislocation to the variety previously described as forward. The annular ligament is commonly torn.

**SYMPTOMS.** The head of the radius is felt in its abnormal position.

The arm is held in a position midway between supination and pronation, and is flexed partially, but cannot be moved beyond a right angle. The lateral diameter of the elbow is increased, rather than the antero-posterior diameter, which occurs in the forward variety.

**PROGNOSIS.** The prognosis should be guarded, as it is impossible at times to effect a reduction, though when the annular ligament is not extensively torn little trouble is experienced.

**TREATMENT.** Reduction by extension and counter-extension combined with pressure inward and backward over the head of the radius. The arm is dressed in a right-angled position and the hand carried in a sling for two weeks.



Fig. 178. Author's Case—Dislocation of Radius.

#### **Downward Dislocation of the Radius.**

—This variety occurs for the most part in very young children, especially happening when they are lifted from the ground by the arms. The head of the radius is drawn downward so that it is held firmly by the orbicular ligament. This variety is described by some as “dislocation by elongation.” Great pain is experienced and the limb hangs by the side of the child pronated and partially flexed. (Fig. 178).

The prognosis is always favorable if the injury is recognized early and the dislocation is promptly reduced.

The treatment is to produce slight extension and forcibly supinate the hand. A slight click will usually be heard when the head of the bone resumes its normal position. Absolute rest of the joint should be insisted upon for at least one week, and the arm should be dressed in a right-angled felt or plaster of Paris splint.

**Dislocation of Both Bones at the Elbow Joint.**—The varieties are backward, forward, and inward and outward.

Backward dislocation is produced by falls upon the hand, and blows received upon the inner surface of the elbow and upon the lower end and back of the humerus. It never occurs from falls upon the elbow. The coranoid process of the ulna may be felt above the condyles upon the posterior aspect of the arm, or it may occupy the olecranon fossa of the humerus. The biceps and brachialis anticus muscles may be ruptured or stretched. The arm cannot be straightened or greatly flexed and it is found in a position slightly flexed. The swelling may be so great that the condyles of the humerus cannot be accurately made out, but when it is possible to determine their exact positions the relationship which the condyles bear to the olecranon and the styloid processes of the ulna will determine the injury beyond question. The olecranon process is very prominent. (Fig. 179.)

This dislocation has been successfully reduced even after the end



of two weeks, but usually some impairment of the function of the elbow-joint results unless reduction has been accomplished early. The coranoid process of the ulna may be broken at the time the injury is received or fractured during the attempts at reduction. After reduction has been made, if the coranoid process has been broken, the dislocation will invariably recur.

**TREATMENT.** The choice of methods of reduction is between Cooper's method and the employment of extreme or hyper-extension accompanied with traction.

Cooper's method of reduction is as follows: The patient is seated in front of the surgeon who places his knee in the bend of the elbow, allowing the upper ends of the bones of the fore-arm to receive the greater part of the pressure. Grasping the wrist, the arm is bent over the knee, and after the coranoid process is lifted out of the fossa of the humerus the arm is forcibly bent. The dressing



Fig. 179. Author's Case of Dislocation of Both Bones of the Forearm Backward.

should be a right-angled felt splint loosely applied, or a plaster of Paris splint, which should be worn for ten days.

The joint may be manipulated in a similar manner by grasping the lower end of the humerus with one hand and the upper ends of the bones of the fore-arm with the other.

**Dislocation of the Radius and Ulna.—FORWARD.** This is caused by falls upon the elbow. This dislocation is usually accompanied with fracture of the olecranon process of the ulna. Extensive laceration of the ligaments always accompanies it. The arm will be found lengthened, and the olecranon process will be absent from its normal position. The elbow will appear flat and abnormal, and lateral motion will be present. (Fig. 180.)

When fracture of the olecranon process takes place fibrous union will usually result, but in the majority of cases the usefulness of the elbow is not impaired in simple dislocation.

**TREATMENT.** The treatment in reduction is accomplished by forced flexion combined with extension. Counter-extension is made from the lower end of the humerus. The best dressing is a right-angled felt splint, which should be worn for ten days.

**Dislocation of the Radius and Ulna Outward.—COMPLETE.** Caused by falls upon the elbow or hand. The pronator muscle draws the head of the radius forward. Rupture of the annular ligament often occurs. Prominence of the internal condyle of the humerus is noticed, and the head of the radius is found in its abnormal position. The arm appears shortened and the hand is always found in pronation.

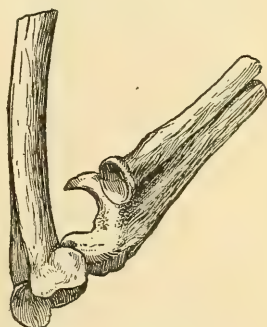


Fig. 180. Dislocation of Radius and Ulna.



Reduction is usually easily accomplished and the results are good, as few cases with serious complications have been reported.

**TREATMENT.** Forced extension with traction while the fore-arm is held in pronation. The elbow should be fixed in a flexed position for ten days, the dressing most suitable being a posterior right-angled felt splint. Plaster of Paris may also be used as a dressing.

**Incomplete Outward Dislocation of Radius and Ulna.**—Caused by blows upon the inside of the elbow or falls upon the elbow. When the annular ligament is ruptured the radius is displaced forward or backward, while the ulna occupies the position which the head of the radius should normally occupy. The ulna may not have travelled so far externally and may still be found articulating with a part of the trochlear surface of the humerus. The arm is flexed and pronated, the inner condyle of the humerus is found to be prominent, and a great amount of lateral motion exists.

**PROGNOSIS.** The prognosis is favorable, and even in those cases where attempts at reduction have been unsuccessful the entire function of the elbow has not been lost.

**TREATMENT.** Reduction is accomplished by extension with pressure upon the outer side of the upper end of the fore-arm, and traction. The elbow-joint should be kept at rest for two weeks, the dressing consisting of a right-angled felt or plaster of Paris splint.

**Inward Dislocation of the Radius and Ulna.**—This dislocation is produced by falls upon the elbow or hand. The cavity of the ulna embraces the internal epi-condyle and the cup-shaped head of the radius occupies the trochlear surface of the humerus. Shortening cannot take place. The olecranon process may be felt near the upper condyle, and the external condyle of the humerus will be found to be very prominent. The prognosis is good, but some impairment of motion at the elbow is noticed in many cases.

**TREATMENT.** The dislocation is reduced by the employment of extension and traction, with internal lateral pressure. The elbow is carried in a flexed position for ten days.

**Long Standing Dislocation of the Elbow Joint.**—Dislocations which have been left unreduced offer very little chance of success as regards later reduction after a few weeks have elapsed, especially in the young. Adhesions form very rapidly in the elbow-joint after any injury, and when two weeks have passed very little can be accomplished unless operative measures are instituted.

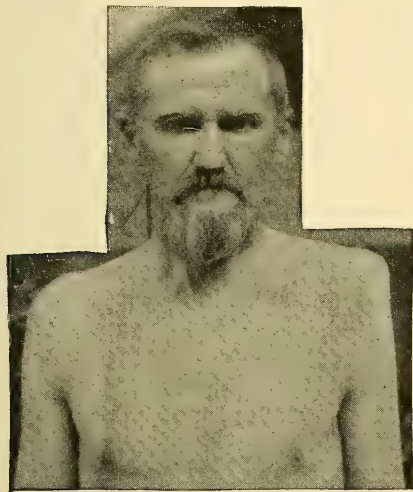
## CHAPTER XII.

### DISLOCATIONS OF THE SHOULDER.

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**Classification.**—Great inaccuracy has always existed in the grouping of dislocations about the shoulder, but the following classification adopted by Flower and Hulke is the best: Sub-coracoid, sub-clavicular, subacromial, sub-spinous, sub-glenoid, supra-glenoid.

Dislocations about the shoulder are very common, and in hospital practice they form the majority of dislocations admitted. Men and women are equally liable to them and the force of the injury producing some of these dislocations is, contrary to the general rule, sometimes slight. Good, useful joints usually follow these injuries, and in many cases the patients are perfectly free from pain and inconvenience as soon as reduction is accomplished.



**Fig. 181.**  
**Sub-Coracoid Dislocation.—Bishop.**

**SUB-CORACOID AND SUB-CLAVICULAR.** The sub-coracoid dislocation occurs more frequently than any of the other varieties and differs from the sub-clavicular in that the head of the bone in the latter variety lies nearer the sternum and beneath the clavicle. It might be described as a forward and inward variety, while the sub-coracoid could be called forward, downward and slightly inward. These two varieties should

be described under the same head, inasmuch as the sub-clavicular form appears to be an exaggerated variety of the sub-coracoid. They are caused by falls upon the shoulder and muscular contraction. The latter cause rarely produces this dislocation. The capsule is torn, in the majority of cases, at the lower border, but it is possible for the sub-coracoid variety to occur without rupture of the capsule. The supra and infra-spinatus muscles may be torn.

*Symptoms.* The head of the humerus may be felt or even seen in its abnormal position (Fig. 181). The arm cannot be moved forward and it is impossible to place the hand upon the opposite uninjured shoulder, while the elbow of the injured arm rests against the chest. This symptom is common to all dislocations in this region. The arm is abducted, especially in the sub-clavicular variety. Little disturbance to the axillary nerves and vessels ever occurs, but obstacles frequently arise which prevent the reduction of this dislocation.

*Treatment.* All rules laid down for the reduction of this variety apply equally well to many of the other forms of dislocation in this neighborhood. The danger of placing an unbooted heel into the axilla as a means of effecting counter-extension is very great and should never be employed. The foot of the surgeon so placed while the extension is being carried out does not produce counter-extension, because the heel does not come into contact with any bony eminence but rests against the muscles and axillary contents. It may have some

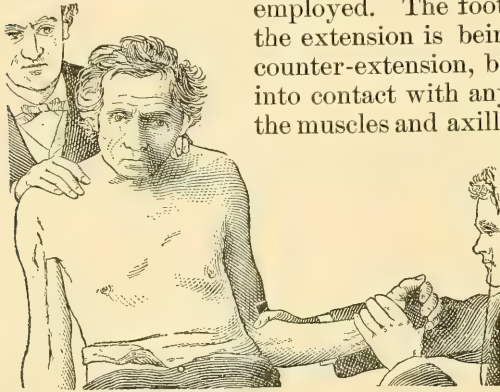


Fig. 182.

**Kocher's Method: First Movement, Outward Rotation.**

effect, acting as the fulcrum of a lever, by pressing the head of the bone into the glenoid cavity. It is also dangerous in the extreme to bring the arm perpendicularly above the head and to employ traction while the arm is so raised. The reduction may sometimes be brought about by this means but should only be resorted to after all other

methods have failed. Cooper's method of using pulleys to drag the head of the bone into place is advisable only after manipulative methods have failed.

*Kocher's Method.* The patient should stand facing the surgeon, who flexes the forearm upon the arm to a right angle and adducts the arm (Fig. 182). The hand is then thoroughly abducted and the elbow carried upward across the chest. The rotation and adduction should be continued while the elbow is brought forward and upward (Fig. 183). The hand is then adducted, hence the head of the humerus is rotated inward, and the hand of the injured side is placed upon the sound shoulder (Fig. 184). The moment the head of the bone passes into the glenoid cavity a distinct sound is heard which indicates that the dislocation has been accomplished. The hand may be cautiously returned to the side, and if it is found that the symptoms of the reduction have disappeared and that the head of the bone has left its abnormal position the hand should then be returned to the uninjured shoulder, the elbow resting against the chest, Velpeau's position, and Velpeau's dressing applied. The arm should be kept in this position for about ten days, and the patient cautioned not to use the arm during the following week.

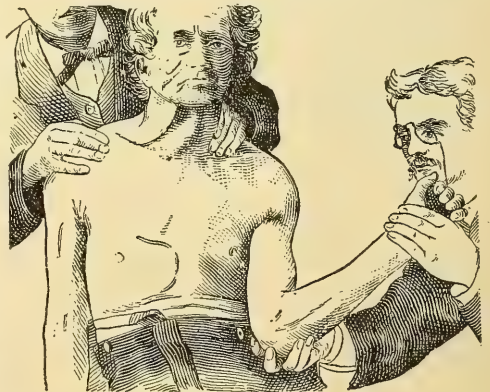


Fig. 183.

**Kocher's Method: Second Movement, Elevation of Elbow.**

*Smith's Method.* The fore-arm is flexed upon the arm, the elbow is abducted, the head of the humerus is rotated outward, and while the



elbow is being returned to the side rotation inward of the head of the humerus is produced.

When Kocher's and Smith's methods fail and extension and counter-extension are to be employed the only fixed point from which counter-extension may be obtained is the acromion process of the scapula. An assistant may make counter-extension over this point with his hand, or the surgeon may make use of his foot placed in the axilla. A very useful suggestion has been made by McBurney. He advises the use of a strong hook (Fig. 185) made for this purpose and inserts it into a hole made by a drill (Fig. 186) into the spine of the scapula, thus limiting the movements of the scapula. This hook takes the place of the hands of an assistant or the heel of the surgeon, as advised for making counter-extension, and effectually anchors the scapula. Anesthesia is not necessary but a few cases cannot be reduced without its use. It is often only necessary to engage a patient in conversation, and while his mind is thus taken away from his injury to move the humerus in the direction of least resistance, following as nearly as possible Kocher's directions. The surgeon will often be gratified to find that he has reduced the dislocation by these means with comparative ease and little or no pain whatever to the patient.

*Complications.* Fracture of the neck of the humerus accompanying a dislocation of the shoulder not infrequently occurs. All writers and investigators until recently agreed that this injury demanded either excision of the head of the humerus or the establishment of a false joint. It is useless and impracticable to attempt the reduction of a dislocation at the shoulder-joint, accompanied by a fracture of the neck of the humerus after the union of the said fracture has taken place. McBurney has shown the feasibility of an operation whereby the dislocation may be reduced and the fracture treated so as to give good and perfect use of the arm. He suggests cutting down upon the outer aspect of the arm, the incision being three inches or more long, beginning just below the acromion process of the scapula and running directly downward parallel with the shaft of the humerus. When the head of the bone is reached a hole is made into the neck of the bone by a drill (Fig. 186). The beak of a strong hook (Fig. 185) is introduced into this opening and the dislocated head of the bone is then drawn into its proper position. An assistant should at the same time make counter-extension from the acromion process of the scapula. The fracture should then

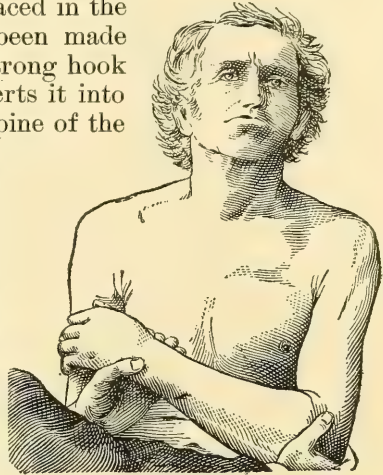


Fig. 184.

Kocher's Method; Third Movement: Inward Rotation and Lowering of Elbow.

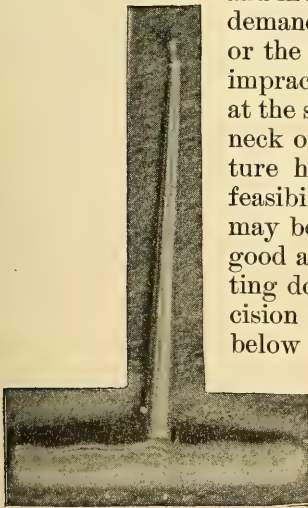


Fig. 185. McBurney's Strong Hook.

be treated in the same manner as any compound fracture, and it is not necessary to introduce metallic sutures into the bone ends.

**SUB-GLENOID.** Many of the reported dislocations into the axilla have not been downward, or sub-glenoid dislocations, and should have been placed in the group of sub-coracoid. Sub-glenoid, properly speaking, is a rare variety.

It is caused by falls or blows upon the shoulder and by muscular contraction. Falls upon the hand and elbow have been reported as causing this injury. The capsule is lacerated at its lower border and the supra-spinatus, sub-scapularis, deltoid and biceps muscles may be torn. The greater tuberosity of the humerus is sometimes fractured.

*Symptoms.* Absence of the head of the bone from its socket and its presence in the axilla are usually made out. The acromion process of the scapula is very prominent, the elbow is carried away from the body and the arm is lengthened. The hand of the injured side cannot be placed upon the shoulder of the opposite side while the elbow of the injured side touches the thorax. The elbow is moved with especial difficulty, and when it is carried inward the patient suffers great pain. Loss of sensation or numbness of the arm may be noticed.

The dislocation is usually readily reduced, but partial paralysis of the muscle of the arm sometimes lasts for months or even years. The limb will never be as strong as it was before the injury occurred.

*Treatment.* Kocher's method may be successfully employed, but traction with the arm abducted, combined with pressure over the head of the bone exerted through the axilla, will be found necessary in many of these low forms of dislocations. When Kocher's method fails the operation will often be successful by repeated efforts in forcibly carrying the elbow across the chest while the hand is abducted. This is simply one movement of Kocher's method.

**SUB-SPINOUS AND SUB-ACROMIAL VARIETIES.** The sub-spinous dislocation is an exaggerated form of the sub-acromial. These forms constitute the variety sometimes spoken of as backward or posterior. They are caused by falls upon the shoulder, elbow or hand. The head of the humerus is found either below the acromion process of the scapula or still further inward below the spine of the scapula. The infra-spinatus and sub-scapular muscles may be torn.

*Symptoms.* The presence of the head of the humerus in its abnormal position, abduction of the arm, and rotation of the arm outward while the elbow projects forward, characterize this dislocation. In the sub-spinous form the elbow will be found decidedly abducted. It is impossible to place the hand of the injured arm upon the opposite shoulder while the elbow of the injured side is held in contact with the chest.

Reduction may be readily accomplished, and it is rare to find any interference with the axillary nerve. After reduction, however, the dislocation shows a great tendency to recur, probably because the muscles mentioned above have been ruptured.

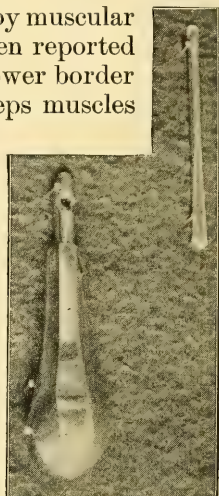


Fig. 186. Showing Drill Hole for Insertion of Hook.

*Treatment.* The treatment is by traction downward while the arm is slightly abducted and carried forward.

**SUPRA-GLENOID.** This dislocation is often described as an upper one and is rare. Only a few authentic cases have been recorded. It is said to be produced by falls upon the shoulder or hand, and in machinery accidents where the head of the bone has been forced directly out of the socket. The deltoid muscle is injured and is often found folded upon itself over the shoulder. Much discussion has been raised about this injury, and fracture of the coracoid process of the scapula probably always accompanies this dislocation.

*Symptoms.* The arm is held close to the side of the body, adducted or abducted, and rotated outward. The head of the humerus may be seen or felt above the acromion process of the scapula, and the function of the shoulder joint is entirely lost. The patient is unable to place the hand of the injured arm upon the shoulder of the opposite side while the elbow is held in contact with the chest. Since the injury is so rare it is impossible to prognosticate accurately, but there is no reason why good use of the arm should not result after an early reduction; but if the acromion process of the scapula is fractured there is always a tendency toward recurrence.

*Treatment.* The dislocation is reduced by traction downward while the elbow is abducted.

**Dislocations of Long Standing.**—When the head of the humerus has been out of the glenoid cavity for a long period it is extremely doubtful whether any benefit is ever derived from surgical interference. The cavity may be filled up with new, partly organized material, and this will prevent the head of the bone from occupying its old position. Again, nature may have been partially successful in forming a new socket for the head of the bone in its abnormal location. In the majority of cases where operations have been performed and the head of the bone has been returned to its former position the operator has been disappointed to find, after the expiration of weeks or months, that the bone occupies exactly the same position that it did before he began his treatment.



### CHAPTER XIII.

## DISLOCATION OF THE INFERIOR MAXILLARY.

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**Varieties.**—These dislocations are forward and backward. Their divisions may be either bilateral or unilateral. An outward form is sometimes noted and when it occurs it is accompanied by a fracture of the condyloid process.

**FORWARD, UNILATERAL OR BILATERAL.** The cause is the same in both varieties, and is usually produced by muscular action, rarely by external violence. Sneezing, vomiting, epileptiform convulsions, violent spells of laughing, attempts to extract teeth, and efforts to take large bodies into the mouth, as billiard balls, etc., have all been reported as causes of these injuries.

The powerful action of the external pterygoid and the masseter muscles lifts the condyloid process of the inferior maxillary bone forward out of the glenoid fossa. The capsule must be relaxed or lacerated before the luxation can take place. The laceration usually occurs anteriorly. This must not be confounded with the partial luxation or subluxation which occurs in many people, especially children and young adults, the only symptom of which is a snapping sound which is heard when the mouth is widely opened.

*Symptoms.* The jaws are wide open, the separation is greater in the bilateral variety, and lateral deviation is noticed in the unilateral variety. The teeth of the upper and lower jaw cannot be approximated. Saliva constantly dribbles from the mouth. The pain accompanying this dislocation is not always severe. Re-occurrence is liable at any time, but no permanent disability will follow.

*Treatment.* The patient is placed on the floor directly in front of the surgeon, and downward and backward pressure is made by means of the thumbs placed over the molars, while at the same time the chin is elevated by the fingers. A cork or a piece of wood introduced between the upper and lower molars to act as the fulcrum of a lever will often be of great aid in reducing this dislocation.

**BACKWARD, UNILATERAL OR BILATERAL.** This form is produced only by external violence. The dislocation is frequently accompanied by fracture of the temporal bone near the bony portion of the auditory canal which is usually produced by the condyloid process of the inferior maxillary being pushed forcibly backward. The lips can be closed but the jaw cannot. The lower jaw recedes and may deviate to one side, if unilateral. Many cases die of cerebral complications.

*Treatment.* It is difficult to reduce this dislocation but the same means should be adopted as in the forward variety, with the exception that the pressure should be made downward and forward instead of downward and backward. Oftentimes it will be necessary to convert a bilateral dislocation into a unilateral one as the first step, and then afterwards reduce the unilateral dislocation thus produced.

**Dislocations Outward Accompanied with Fracture.—**

These luxations are uncommon and only a few examples have been recorded. They are caused by direct violence. The line of fracture is oblique, and may be located near the condyloid process or further down the ramus of the jaw.

The usual symptoms of dislocation of the jaw will be present. The articular process may be felt at the side of the face, and crepitus will usually be found at the seat of the fracture. Loss of function, pain and swelling are always present.

The prognosis is unfavorable and great deformity frequently follows this injury.

**TREATMENT.** In effecting reduction direct pressure may be of service, but as a fracture is present the leverage power, which the unbroken jaw gives in ordinary dislocations, is lost. It may be justifiable to wire the fragments after reduction has been accomplished.

## CHAPTER XIV.

### THORACIC DISLOCATION.

**Dislocation of the Clavicle.**—The clavicle may be dislocated at its sternal and acromial ends. The acromial variety is the most common.

The sterno-clavicular variety is displaced forward, or forward and upward, rarely backward. It is caused by blows or falls upon the shoulder or sternum. The capsular, inter-articular, sterno-clavicular and rhomboid ligaments are more or less ruptured.

**SYMPTOMS.** The backward variety is rare and only a few cases have been reported. In the forward (Fig. 187) or in the forward and upward variety the end of the clavicle may be felt or even seen in its abnormal position. Partial loss of function of the shoulder and pain upon using the shoulder will always be noticed. The tendency to recur is decided but little disability arises, even in those cases where this dislocation remains unreduced.

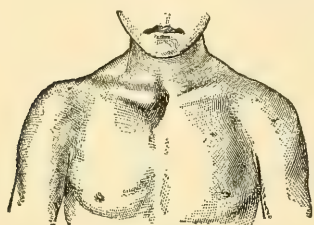


Fig. 187.

Dislocation of sternal end of Clavicle forward.

**TREATMENT.** The deformity is reduced by drawing the shoulders forcibly backward and combining pressure over the sternal end of the clavicle. A posterior figure-of-eight bandage of the shoulders should be used, and rest in bed be insisted upon during the first two weeks of the treatment. The author has found Sayre's dressing as advised for fractured clavicle, combined with a compress over the sternal end of the clavicle, to be of service.

**ACROMIO-CLAVICULAR DISLOCATIONS.** These may be of the upward, outward, downward and sub-coracoid varieties.

They are produced by falls or blows upon the shoulder. Blows received by heavy doors swinging and striking patients on the shoulder have also produced this injury. The two acromio-clavicular ligaments and that portion of the coraco-clavicular ligament called the trapezoid ligament are ruptured.

*Symptoms.* In the upward variety (Fig. 188) the acromion end of the clavicle projects upward about one inch, and there is some loss of motion of the shoulder. Pain and swelling are always present. The downward variety is rare, and when present the point at which the dislocation occurs is marked by a hollow, the head of the bone lying beneath the acromion process of the scapula. The sub-coracoid variety is very rare. Simultaneous dislocation of both ends of the clavicle sometimes takes place, and a few such cases have been recorded.

*Prognosis.* Good use of the shoulder will follow this injury, but in the majority of cases, especially in the upper variety, reduction will be followed by a recurrence of the deformity.

*Treatment.* The upward and outward varieties may be reduced by pressure downward over the acromion end of the clavicle and at the same time by elevating the shoulder. The powerful action of the muscles tends



constantly to reproduce the dislocation, and the most effectual dressings at times fail to obtain good results. The shoulder should be elevated and the arm brought across the chest at right angles to the chest. A band of adhesive plaster three inches wide should be placed over the shoulder and brought around under the arm just in front of the elbow.



Fig. 188.  
Dislocation upward of the Acromion End of the Clavicle.

**Dislocation of the Ribs and Cartilages.**—VERTEBRO-COSTAL DISLOCATION. This is rare. External violence is the cause. The head of the rib may be separated from the body of the vertebra with which it articulates or from the transverse process.

*Symptoms.* There will be pain over the head of the rib, and when pressure is made over the dislocated end some motion may be noticed. The patient is able to walk about and suffers little inconvenience from the injury. Recurrence of the dislocation may take place at any time.

*Treatment.* The same treatment as advised for fracture of the ribs (Fig. 132) should be employed.

**CHONDRO-COSTAL DISLOCATION.** This is caused by falls, or violent efforts at coughing. The accident usually occurs in children and young adults. And therefore it is found only in those individuals where ossification has not taken place. Abnormal mobility and pain are experienced on deep inspiration. Recurrence of the dislocation may be anticipated at any time. Some deformity always exists after this injury.

*Treatment.* The treatment consists of adhesive straps applied in the same manner as advised for fracture of the ribs and should be used for four weeks (Fig. 132).

**CHONDRO-CHONDRAL DISLOCATION.** This is caused by direct violence from falls or blows. This injury takes place only between the adjacent cartilages of the sixth, seventh and eighth ribs. The lower cartilage is said to be dislocated from the upper. This dislocation may recur at any time through life. Some deformity will always remain.

*Treatment.* The treatment consists of pressure over the dislocated cartilage, while the patient takes a deep inhalation, which will effect reduction. Strapping the chest is the best treatment, and should be continued for four weeks. (Fig. 132.)

**CHONDO-STERNAL VARIETY.** This form is due to external violence, or in children by falling against sharp objects, as edges of tables. This injury occurs more often than any of the preceding varieties and may take place at any age. The displacement of the sternal and of the cartilage may be backward or forward; the sternal variety is the most common. Recurrence of the dislocation is frequent.

*Symptoms.* Abnormal mobility, pain and embarrassed breathing will be noticed. The region over the sternal end of the cartilage will be marked either by a prominence or a depression, according to the variety of the dislocation.

*Treatment.* The chest should be strapped (Fig. 132), in addition to which a compress may be placed over the dislocated end of the cartilage.

## CHAPTER XV.

### DISLOCATIONS OF FOOT AND LOWER LEG.

**Dislocation of the Phalanges.**—These may be either backward or forward, and are caused by direct violence received on the ends of the toes. They are often compound and complicated. A prominent depression over the joint will determine the dislocation and, as in the fingers, the three varieties may be observed—complete, incomplete and complex. The interposition of soft tissue, as tendons, between the joint surfaces may render the reduction impossible. The distal end may lie at a right angle to the proper axis of the toes.

**TREATMENT.** Reduction is accomplished by extension and counter extension combined with flexion and extension. Dorsal flexion may be employed. The Indian puzzle (Fig. 174) may be of service in reducing this dislocation. Figures 175 and 176 show instruments which may also be of use. In many cases amputation will be necessary.



Fig. 189. Dislocation of Tarsus.

**Dislocation of the Metatarsus.**—The metatarsal bones may be dislocated from the tarsus in any direction. The cause is usually from a fall upon the feet, or a severe twist, while the toes are held firmly by some object. Extensive rupture of the ligaments is always noticed, with prominence of the metatarsal bone in an abnormal position. If

the entire row is dislocated the foot will be shortened.

The reduction of this class of dislocations is easily accomplished and recurrence of the deformity is rare.

**TREATMENT.** The reduction is effected by making pressure directly over the head of the bone, using a splint or a plaster of Paris dressing on the sole of the foot for two weeks.

**Dislocation of the Tarsus.**—The tarsal bones may be dislocated, one from another in any direction, and these dislocations are often compound. The astragalus is the one most commonly dislocated. It may be displaced in any direction and the varieties, forward, backward, inward and outward have been observed. (Fig. 189). Falling from a height and striking upon the feet is a frequent cause. When the astragalus is dislocated the deformity may be very marked, as the tibia and fibula often articulate directly with the calcaneum. Swelling and ecchymosis are early and prominent symptoms. The other tarsal bones when dislocated may be easily detected in their abnormal positions. Very poor results follow these injuries. Amputation after a few weeks may be necessary on account of gangrene.

**TREATMENT.** Flexion and extension, with a rocking motion and pressure made over the dislocated bone, will reduce many cases. Rest should be given to the foot for one week. No especial dressing is required.



**Dislocation of the Upper End of the Fibula.**—It may be of the forward or backward variety. It is generally produced by falls, the force of the injury being applied directly over the head of the bone. It is attended with severe laceration of the ligaments.

**SYMPTOMS.** The forward variety is the most common form. Prominence of the head of the fibula near the ligamentum patellæ is the leading symptom.

In the backward variety the head of the fibula may be felt about one inch backward from its normal situation and the foot is generally turned outward. Little inconvenience or loss of function follows this accident.

**TREATMENT.** Flexion of the leg upon the thigh, combined with pressure applied directly over the dislocated head of the fibula will reduce the dislocation. A plaster of Paris dressing should be employed for two weeks.

**Dislocation of the Lower End of the Fibula.**—Only a few isolated cases of this dislocation have been known to occur, but the

backward variety has been reported as caused by a wagon wheel passing over the ankle, forcing the end of the fibula backward.

**Dislocation of the Lower End of the Tibia and Fibula.**—This injury is rare, and when it does occur it is usually accompanied with a fracture.

**VARIETIES.** The varieties are backward, forward, inward and outward. The forms are named from the abnormal positions of the tibia. Falls from different angles upon the sole of the foot are the cause. It is usually accompanied with a fracture of the internal or external malleolus. Extensive laceration of the lateral ligaments always occurs.

*Symptoms.* The symptoms in the backward variety are forced flexion and prominence of the astragalus in front.

In the forward variety there are forced extension and prominence of the end of the tibia in front of the joint.

The inward dislocation is usually accompanied with fracture of the fibula and prominence of the internal malleolus.

The outward is generally accompanied with fracture of the fibula and the internal malleolus. There is prominence of the external malleolus. (Figs. 190 and 191.)

*Prognosis.* This is favorable. Good use of the ankle follows this injury in the majority of cases, but the deformity often remains more or less marked.



Fig. 190.  
Dislocation of Foot inward.  
—Fitzgerald.



Fig. 191.  
Double Dislocation of Feet inward.—  
Fitzgerald.



*Treatment.* Reduction is easily accomplished, but when a fracture is present much difficulty is experienced in preventing the dislocation from recurring. A plaster of Paris dressing should be used.

**Dislocation of the Head of the Tibia Backward.**—VARIETIES. The varieties are complete and incomplete. Falls from heights, striking directly upon the foot while the body inclines backward, is a not uncommon cause.

There are often observed incomplete rupture of the posterior ligaments and pressure upon the popliteal nerve and vessel.

*Symptoms.* The incomplete is attended with rupture of the posterior, crucial, and usually the lateral ligaments. Pressure upon the popliteal structures, and in some cases complete occlusion of the popliteal vessels, may occur. Prominence of the condyles of the femur is a prominent symptom. The leg is always in hyper-extension. The outlines of the patella are sharply marked.

*Prognosis.* There may be permanent injury to the popliteal nerve, or gangrene of the leg from stoppage of the circulation may follow. If reduction has been performed early little trouble follows, but in many cases the usefulness of the joint is destroyed from laceration of the ligaments.

*Treatment.* It is reduced by extension and counter-extension, combined with rocking of the joint from side to side or by producing slight flexion. Obstinate cases may be treated by forced flexion alternated with extension of the leg. The leg is placed in a plaster of Paris dressing which includes and immobilizes the knee.

**Dislocation of the Head of the Tibia Forward.**—VARIETIES. These are the complete and incomplete. They are produced by heavy objects striking the upper end of the tibia. In some cases the force is transmitted from the foot upward, from falls upon the foot. Laceration of the anterior ligaments occurs. Symptoms of pressure made by the dislocated bones upon the popliteal nerve and vessels may be anticipated. The patella and tibia are prominent, while a depression exists above the joint. The leg is in hyper-extension.

Extensive laceration of the ligaments always occurs and gangrene of the leg may develop where the circulation is impeded at the popliteal space.

*Treatment.* Reduction is accomplished by extension and counter-extension combined with manipulation. The knee is confined in a plaster of Paris dressing for two weeks.

**Dislocation of the Head of the Tibia Inward and Outward.**—This may be complete or incomplete. \*The former variety is rare. It may be produced by injuries which fix the leg as in a vise and cause the weight of the body to be sustained by the knee. Laceration of the lateral ligament occurs.

In the inward variety the symptoms are prominence of the external condyle of the femur and the fact that the leg is found in extension.

In the outward variety there is prominence of the internal condyle of the femur with the leg in extension. The dislocation is readily reduced, and no great interference with the nerves and vessels of the popliteal space ever occurs.

The treatment consists of direct pressure with slight extension, which

will be sufficient to accomplish the reduction. A plaster of Paris dressing is applied and is made to include the knee.

**COMBINED VARIETIES.** The backward and forward forms may be combined with either of the lateral varieties and when these combinations exist the cause, pathology, symptoms, prognosis and treatment differ but little from any of the other varieties.

**Dislocation of the Patella.**—This may be inward, outward, and upon its axis.

**CAUSE.** The most common cause is a blow received either upon the inner or outer side of the knee, usually from falls upon the knee while the leg is flexed at the knee. Injury to the capsular ligament and the ligamentum patellæ usually take place.

**SYMPTOMS.** The symptoms are the presence of the patella in its new position with complete locking of the joint, accompanied with great pain, especially upon every effort to bend the knee. This makes the diagnosis clear (Fig. 192). If the capsular ligament has been extensively torn recurrence occurs from the slightest mis-step or twist.

**TREATMENT.** Reduction is effected by making lateral pressure while the leg is extended upon the thigh. An elastic knee cap should be worn for several weeks or months and, in some cases, years.



Fig. 192.

Long standing irreducible dislocation of Patella inward.

## CHAPTER XVI.

### DISLOCATIONS OF THE HIP.

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**General Considerations.**—These dislocations occur in the majority of cases in adult males. The force of the injury producing them is very great, and extensive laceration of the ligaments and soft tissues about the joint always takes place. The ligamentum teres is nearly always torn, but the “Y” ligament remains uninjured in the majority of cases. The rent in the capsule through which the head of the bone passes varies in extent and it is many times increased in size during attempts at reduction. During such attempts one form of dislocation may be converted into another, and before reduction can be accomplished in these cases the dislocation must be converted into its original variety. The everted dorsal, which is an exaggerated form of the dorsal, produced by lowering the leg, must be converted into the low variety of a “backward upon the dorsum of the ilium” before reduction is attempted.

**Classification.**—The classification adopted by Stimpson is as follows: Backward, downward and inward, forward and upward, directly upward, downward.

**Backward.**—This variety includes under one head the old forms, “backward upon the dorsum of the ilium,” the “ischiatric,” “dorsal below the tendon,” “sacro-ischiatic,” “backward into the ischiatic notch,” and “iliac.” This is the most common form. The everted dorsal is a form of this division made possible by rupture of one branch of the ilio-femoral ligament.

**CAUSE.** The cause is falling upon the foot from heights while the leg is slightly flexed upon the thigh and the thigh flexed upon the body. The leg is held in adduction at the time of the receipt of the injury.

**PATHOLOGY.** The ilio-femoral ligament is not often ruptured, but the capsule is rent at its posterior border and the ligamentum teres is always torn. The obturator internus and pyriformis muscles may be ruptured.

The knee is found flexed, adducted, and the sole of the foot rests upon the instep of the sound side (Fig. 190). Preternatural immobility and fullness over the posterior surface of the ilium are prominent symptoms.

#### DIFFERENTIAL SYMPTOMS.

##### *Dislocation Backward.*

The force of the injury is tremendous. The patient gives a history of falling from a great height, striking upon feet.

Abnormal immobility.

Inversion of the toes.

The trochanter lies nearer the ilio-femoral line than normally.

Usually occurs in adult males.

The dislocation does not tend to recur after reduction.

##### *Fracture of the Neck of Femur.*

(Small part of the neck.)

The force of the injury may be slight and is produced by direct violence.

Abnormal mobility.

Eversion of the toes.

Slight elevation of the trochanter toward the ilio-femoral line.

Usually occurs in old women.

Constant tendency of the displacement to re-appear after the fracture is reduced.



Reduction may be speedily accomplished in recent cases. Some permanent paralysis may follow this injury.

**TREATMENT.** In reducing this dislocation the direction of least resistance should be followed. Hamilton suggests flexing the leg upon the thigh and the thigh upon the abdomen while the leg is held in abduction. With the thigh flexed to a right angle the limb is moved into abduction and outward rotation. At this point extension should be employed, as thereby the head of the femur may be lifted into the acetabulum. Reduction should be accomplished at this point and the leg should be returned to the body while it is abducted and rotated outward. Extension and counter-extension may be produced by pulleys, but this severe method should not be used until after the gentler measures by manipulation have failed to effect a reduction.



Fig. 193.  
Dislocation of the  
Hip Backward. —  
Fitzgerald.

*Cooper's Method* (See Fig. 194). The patient is placed upon his back and the ends of a perineal band are tied to some firm object above his head. The cord which runs from the pulley is fastened to a piece of muslin made fast to the leg above the knee. Adhesive plaster or a moist roller may be used for this purpose. The staple which secures the pulley which is attached to the extension should be so located that the traction will be in the line of the axis of the thigh. The traction should be steady and light at first, and intermittent. Every time the traction is started it should be increased and lengthened in time. The surgeon may render valuable aid by combining manipulation with this method. While the pulleys are in use the leg may be rotated and the flexion increased, or any manipulation thought necessary may be employed.

*Bigelow's Method.* The leg is flexed upon the thigh to a right angle, the thigh adducted, and the head of the femur is rotated inward by carrying the foot away from the body while the knee is firmly and carefully held in adduction.

Bigelow also advised vertical extension as useful. It is necessary to confine the patient in bed for two weeks, but all form of dressing may be omitted.

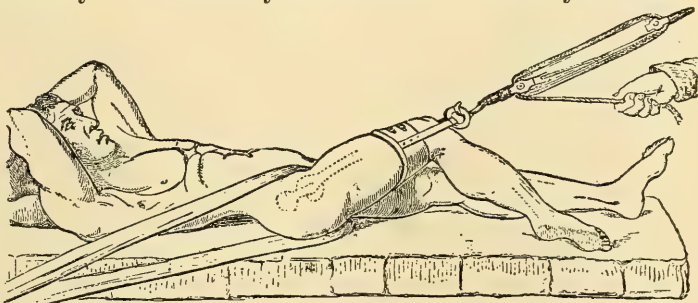


Fig. 194. Reduction of a Dislocation on the Dorsum Ilii by Pulleys.—Sir Astley Cooper's Method.

**Downward and Forward Dislocation.**—This has been described under the following names: "Downward into the foramen ovale," and "downward and forward into the obturator foramen." This dislocation is produced by falls from great heights, striking upon the feet while the

leg is abducted. The head of the femur is drawn downward and inward, and rests either over or in the thyroid foramen.

**SYMPTOMS.** The leg appears longer than its fellow; it is held in abduction; it is flexed at the knee and at the pelvis; the foot usually turns out, and is carried away from the body. It is sometimes only slightly flexed at the pelvis and at the knee, and while the foot is inverted and carried away from the body it is at the same time placed a little in front of the patient (Figs. 195 and 196).

**PROGNOSIS.** This dislocation has oftentimes been found impossible of reduction, but in those cases where reduction has been satisfactorily accomplished no impairment of function follows.

**TREATMENT.** To reduce this dislocation it is necessary to move the limb in the direction of the least resistance, which will be found to be



Fig. 195.  
Dislocation into  
Thyroid Foramen.  
—Posterior View.

flexion at the hip, abduction of the leg, and rotation inward. At this period of the manipulation reduction will usually take place. The leg should be returned to the side of the patient after having been first abducted. Extension should be employed while the head of the bone is being rotated, and adduction started. Fig. 198 represents Bigelow's movements for reduction of a dorsal variety and Fig. 197 for a thyroid variety.

Cooper's method by extension (Fig. 194) may be used, but care should be observed that the traction is made in a line which corresponds with one drawn parallel to the shaft of the femur.

**Dislocation Upward and Forward.** — This dislocation is known as a supra-pubic dislocation.

It is caused by falls upon the foot while the leg is thrown backward behind the body.

In this dislocation, as in every other dislocation about the hip, the capsular ligament is extensively torn. Important nerve trunks or vessels may be pressed upon or ruptured. The head of the bone may be found in front of the anterior superior spinous process of the ilium, or it may be found farther forward, near the pubes. The three forms are described by some writers as ileo-pectineal, pubic and intra-pelvic (rare).

**SYMPTOMS.** The head of the bone is felt in its abnormal position, the leg will be firmly fixed and great pain will be experienced when an attempt is made to move the limb. The leg is always everted and carried slightly away from the side of the body. It is not flexed either at the knee or at the hip.

Paralysis of the muscles of the leg may follow this dislocation and in some cases interference in the circulation of the limb has been noticed. After reduction, which is accomplished in the majority of cases without



Fig. 196.  
Dislocation into Thy-  
roid Foramen.—Anterior  
View.



much difficulty, repair takes place rapidly and after two or three weeks the patient will have full use of the joint.

**TREATMENT.** Reduction may be made by traction, which should always be employed when the head of the bone lies especially high, as in the intra-pelvic variety. Flexion of the leg upon the thigh and the thigh upon the abdomen, while the head of the bone is rotated inward and abducted, will usually reduce this dislocation. Rest in bed for two weeks should be insisted upon, although the patient appears perfectly well.

**Dislocations Directly Upward.**—This variety is often called “sub-spinous.” It is produced by falls upon the feet while the leg is carried backward away from the body. Malgaigne states that the head of the

femur is situated about one inch below the anterior superior spinous process of the ilium—just external to the anterior inferior process of the ilium.

**SYMPTOMS.**

Shortening of the limb, abduction and rotation will be noticed. The rigidity of the limb and the position of the head of the bone, which may be felt in its abnormal position,



Fig. 197.

Reduction of Thyroid Variety.

Fig. 198.

Reduction of Dorsal Variety.

will clearly distinguish it from fracture of the neck of the femur.

**PROGNOSIS.** This is less favorable in this variety than in many of the other forms of dislocation. It may be impossible to reduce the dislocation even by repeated trials.

**TREATMENT.** The proper manipulative measures to be employed in this form are as follows: Traction downward in the long axis of the limb, adduction, flexion, and rotation inward. The patient should be placed in bed and the leg should be supported by sand-bags placed on either side of the leg. In the majority of cases it is unnecessary to use any form of dressing.

**Dislocation Downward.**—This dislocation is very rare. Falls upon the feet have not been the cause of this injury in any reported case, but this dislocation has been produced when workmen have been caught under falling walls or banks of earth. The head of the bone may be felt in its abnormal position, occupying neither the ischiatic notch nor the thyroid foramen but found freely movable in its abnormal position. The ligamentum teres is always ruptured, as is also the capsular ligament. The limb is lengthened, the head of the bone is felt in its abnormal position, while abduction, flexion and eversion are absent.



The few cases of this accident which have been reported have all been accompanied by other injuries which alone have proved serious, but the extent of the injury to the joint and neighboring soft tissues produced by the dislocation is likely to be very great.

TREATMENT. Extension with rotation outward will probably effect a reduction, after which the patient should be confined in bed two weeks. A long side splint may be of service but it is not absolutely necessary to use any form of dressing.

## SECTION XII. ORTHOPEDIC SURGERY.

### CHAPTER I.

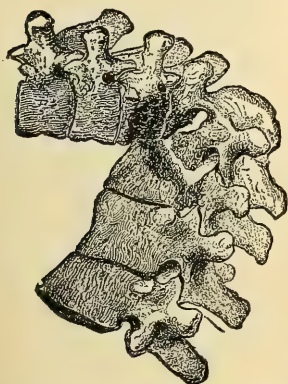
## POTT'S DISEASE, OR ANGULAR CURVATURE OF THE SPINE.

**Synonyms.**—English, spondylitis, kyphosis; French, mal de Pott; German, spitsbuckle. Pott's disease of the spine is a progressive inflammatory lesion of the vertebral bodies or intervertebral disks, leading to their



**Fig. 199.**  
An Instance of Cure of Caries Cervical Vertebrae. Three Vertebrae Merged Into One. Slight Amount of Interstitial Tissue Remaining.

partial or complete destruction, usually terminating in ankylosis with the characteristic posterior deformity. (Young.) The disease rarely extends back of the articular processes, being entirely confined to the bodies of the vertebrae and to the intervertebral substances. Like most forms of suppurative joint diseases this is usually tubercular in origin or there is a tubercular diathesis which is a contributing cause, and the active manifestation of the disease may be excited by any form of accident whereby the bone becomes inflamed and a locus minoris resistentiae is formed, where the deposit and development of tubercular bacilli are established. All of the conditions which enter into the development of tubercular disease in other portions of the body may enter in here, but there is such a large area of spongy bone and so many of the vertebrae may be affected that the deformity resulting and the actual damage done may be of greater extent than at almost any other portion of the body. The spinal column may be likened to a single column of bricks which supports at its top a considerable weight. If a portion of any one brick or series of bricks is removed it affects the integrity of the entire column so that any weight which is supported above by this column will have a tendency to fall. However, it must be borne in mind that the vertebrae are closely united posteriorly



**Fig. 200.**  
Macerated Specimen. Entire Destruction of a Dorsal Vertebra. Ultimate Ankylosis of the Apophysis.

by the ligamentous structures which pass from one spinous process to the

other, and that the articular processes also give a certain amount of support, but that the disease, affecting only the bodies of the vertebræ and not extending posteriorly to the articular processes, does not allow of a complete collapse of the column. A limited amount of support is

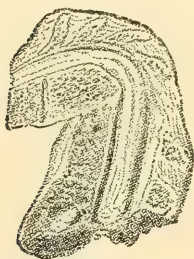


Fig. 201.

Purulent Remnants in Middle Dorsal Vertebræ. Notwithstanding Marked Kyphosis Spinal Cord Not Compressed.



Fig. 202.

Complete Bony Union in Case of Vertebral Caries. Three Dorsal Vertebræ Fused.

gained by these articular processes, and the result is that instead of a complete falling over of the column there is only a partial collapse, in consequence of which the spine projects sharply backward, making a prominence posteriorly which gives the name of "angular curvature" to this disease. This becomes increased more or less, according to the portion of the spine which is affected, the deformity arising also being influenced by the same conditions.

**Pathology.**—First, in the body of the vertebra, or in one of the intervertebral disks, appears a small hyperemic spot which gradually increases in size, develops a small grayish tubercle in the centre and degenerates into tubercular pus. This original focus is surrounded by a layer of inflammatory tissue which cuts it off from the healthy tissue. But the infection of the inflammatory area spreads, more bony tissue is affected and breaks down, until a greater or less amount of bone is destroyed. Sometimes, on account of the inflammation and the cutting off of the circulation, a considerable portion of bone may be deprived of its nutrition and will become necrosed and be thrown off after having been completely disintegrated. The destruction of the vertebra may be confined to only one or perhaps two or three. What is known as the "dry variety," or caries sicca, is exhibited when absorption takes place without the formation of pus, in which usually a larger number of vertebræ are affected. The differ-

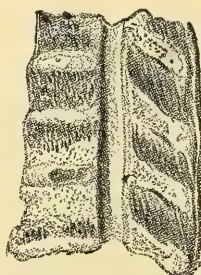


Fig. 203.

Osteitis Caseosa (Tuberculosis) of a Vertebra. (Cross-section.)



Fig. 204.

Spinal Column of a Four-year-old Child. Caries of the Tenth Dorsal and of the Second Lumbar Vertebrae. *ab*, Carious Remnant of the Vertebra. *cd*, Kyphosis; *e*, Last Rib. (After Paul.)



ence in the two varieties makes a difference in the kind of deformity which follows. In the dry variety several vertebræ are likely to be affected, and the result will be that a large posterior curve will be formed, while in the more acute variety, which is accompanied by suppuration, the deformity is more frequently a sharp acute angle than a long curve. As a result of a destructive process in the bodies of the vertebræ the weight above causes them to collapse, and as they give way in front they are held in position posteriorly by the articular processes, which remain unaffected. The result is that there is a caving in in the anterior portion of the vertebral column, while the spinous processes project backward into a more or less acute angle. In the dry variety there is absorption of the diseased portions without the formation of an abscess, while in the ordinary variety there is usually the formation of a tubercular abscess which seeks an exit through some portion of the surface of the body. Sometimes in connection with the disease of the bone there may be meningitis or even a myelitis of the cord; but ordinarily this is not the case, the condition which usually affects the spinal cord being what is known as an external pachymeningitis. This inflammation may cause compression of the cord to such a degree that its function is lost at the point below the pressure, and may result in paralysis of the limbs or of the bladder and rectum. As a rule the disease does not directly affect the cord itself or the meninges, but is confined, as before stated, to parts external to them. The shape of the chest is also affected and its capacity limited. In many cases there are affections of the heart; in some cases displacement, cardiac hypertrophy, valvular lesions and, frequently, phthisis pulmonalis being the final result.

**Etiology.**—In considering the subject of Pott's disease of the spine there must always be borne in mind the strong probability of a tubercular diathesis—the inheritance of a taint from some ancestor. This may not manifest itself until there is an exciting cause, but when once the exciting cause is present the inherited disease is quickly developed. There is very little difference as regards sex, the disease being about equally prevalent in both sexes, and most frequently found in children from the first to the fifth year, and next from the fifth to the fourteenth year, although in some cases it is found even later. One of the exciting causes which has been laid down is the upright position. Animals do not develop diseases of the spine because they are not subject to the same conditions, which come from pressure on the vertebræ from the superincumbent weight. The most frequent locality is in the dorsal vertebræ. Children most frequently affected are those who are known as strumous, or those suffering from catarrhal conditions; they are likely to have catarrhal and glandular swellings and all the manifestations of what is known as a scrofulous condition.

**Symptoms.**—The symptoms in cases of Pott's disease show similarity to those of diseases in the bone in other portions of the body. Where there has been an accident to which the disease can be traced the symptoms are introduced from the first, but in the great majority of cases it happens that there is no accident to which the disease can be directly traced, and in such cases there may be a prodromal stage in which the child seems to exhibit a condition of malaise in which he is less active

than usual, and appears to be in a condition of diminished health. There may also be the stiffness and difficulty of getting about in the morning, the child appearing to improve as the day goes on, such symptoms being frequently mistaken for rheumatism.

Frequently the symptoms do not appear at the point of the disease, but more likely at some other than the directly affected part. This is due to the irritation of the roots of the nerves as they pass from the spinal column; but the pain being referred to the distal portion of the nerve the patient



Fig. 205.



Fig. 206.



Fig. 207.

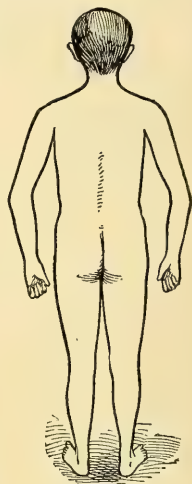


Fig. 208.

Attitudes Illustrating Muscular Rigidity.

commonly suffers from a hacking cough, pain in the stomach, or pain in other portions of the body before the actual disease is discovered, so that the child is frequently treated for conditions which do not exist. The reflex pains may vary according to the portion of the spine which



Fig. 209.



Fig. 210.



Fig. 211.

Attitudes Illustrating Muscular Rigidity.

is affected. If the disease is in the cervical vertebræ there may be such symptoms as difficulty in swallowing, perhaps a constant hacking cough, or the sensation of a cord tied about the neck. If it occurs lower down there may be the cough or certain symptoms referred to the stomach, when the child is frequently treated for indigestion. There may also be the peculiar girdle pain about the chest and body

which is one characteristic of the disease and which comes from spasm of the diaphragm, the patient finding it difficult to take a long breath on account of this pain. There may also be symptoms referred to the lower portion of the body, symptoms referable to the rectum, bladder, lower limbs and abdomen, with more or less paralysis of these organs and, perhaps, paralysis of the limbs. Often much valuable time is lost in the early stages of the disease through not recognizing the real source. There are also the symptoms which accompany any form of chronic bone disease. The child may have pain at night, with the osteitic cry, the sudden waking up and screaming. This symptom is not always present, though very frequently one of the distressing symptoms which accompany the disease.

The most marked and most diagnostic symptom is muscular rigidity. This is evidenced by the rigid position in which the child holds himself when attempting the upright position, shown by the attitude which is assumed by the patient which is almost diagnostic in itself. Of course some variation is found according to the location of the disease, but, as a rule, certain conditions may be found in whatever portion of the spine it occurs. On account of the pain which is caused by any attempt to move the spinal column the patient maintains it in a rigid position. There is also the reflex spastic contraction of the muscles of the spine which accompanies any form of bone disease. As a result of this voluntary and involuntary contraction of the muscles any attempt to change the position is made with the spine held as rigid as possible, so that when the patient turns about instead of moving the head and neck he turns the whole body at once. In stooping to pick an object from the floor, instead of bending forward as a well child would do, he places his hands on his thighs, flexes the hips and knees so that he reaches the floor in a squatting position, but with the spine as nearly straight as possible. This is shown in the illustrations, Figs. 205 to 211.

There is a peculiar position in which the head is held with the chin thrown forward and prominent, and shoulders elevated; the patient is always very slow and deliberate in his movements, and in walking about will always attempt to support the weight of the body by placing his hands on a chair, on his hips, or on articles of furniture about the room. The object of this is to relieve the pressure on the diseased vertebræ and to raise the superincumbent weight from the point of disease. All of these symptoms are to be taken into consideration in making examination of the patient, and if a sharp angle or knuckle is found along the spinal column it adds to the certainty of diagnosis of Pott's disease. The patient soon begins to show signs of chronic invalidism, the loss of sleep begins to tell upon his constitution, the constant pain and diminished appetite cause him to grow thin, he becomes irritable, does not wish to stir, in fact any motion is accompanied by cries and groans.

As a result of the spastic contraction of the muscles and also on account of the pain which is caused by the movements of the chest, the respiration is frequently very much impeded, so that the child, instead of breathing in the ordinary free manner, emits a grunting sound. The chest is held as rigid as possible and the excursion of the ribs is limited. The paralysis may come on early or late, generally late, although in some cases it precedes the deformity. It usually affects both sides and



may vary in degree from slight limitation of function to complete paralysis of all portions below the waist. This is also accompanied by wasting of the muscles. There may be spastic contractions of the psoas muscle to so great a degree as to prevent the child from standing. In some cases there is great weakness of the limbs, which may be wasted, but the reflexes are normal, thus differing from compression myelitis. Deformity is the most characteristic symptom. The projection of the spinous processes backward depends upon the amount of injury done to the spine. The trunk becomes shortened and the limbs appear disproportionately long. If it is in the upper portion of the body the head sinks between the shoulders so that the peculiar deformity of the anterior portion of the chest known as "pigeon breast" is very marked. Where the disease is accompanied by the formation of pus the angle is an acute one, but where there is a long posterior deformity it is usually the result of the dry variety of caries. The presence of an abscess is determined by its appearance upon some of the surfaces of the body. If the disease progresses there may be the formation of the peculiar feature of the disease known as "psoas abscess," in which the pus burrows down along the fascia of the

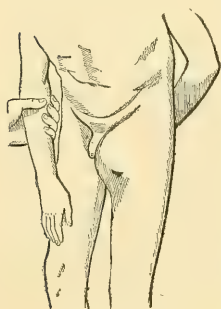


Fig. 212.  
Psoas Abscess.

psoas muscle and perhaps upon the surface of the thigh at a long distance from the focus of the disease. But the abscess is not by any means limited to this region; it may point in any place. Sometimes, if it occurs high up in the column, there is a retro-pharyngeal ab-



Fig. 213.  
Attitude and Characteristic Expression  
in Retro-pharyngeal Abscess.

scuss which may open into the pharynx, burst into larger bronchi, or point and break on the back; or sometimes, though infrequently, it opens into the intestinal canal.

The most frequent variety, however, is the "psoas abscess" before mentioned, which contains the liquid and debris resulting from tubercular disease. When the disease has progressed to this stage it is known as the stage of abscess; the symptoms are marked, the patient becomes emaciated, perhaps totally incapacitated, and may die from exhaustion, from amyloid degeneration of the kidneys or pulmonary tuberculosis. Sometimes the abscess, or rather the fluid portion of the abscess, undergoes absorption, the solid contents become encysted and may remain without giving rise to further disturbance. The general condition of the patient depends largely upon the extent of the disease. The child is likely to be fretful, capricious, often precocious, delicate, takes cold easily, suffers from attacks of indigestion, temperature is higher than in health, in the latter stages suffers from hectic, and is liable to tubercular meningitis.

**Examination.**—In the examination of a child, in the early stages where the disease is suspected, all the symptoms before detailed should be

taken into consideration. The child should be stripped and carefully examined for any prominence of the spine. He should be made to stoop and pick something from the floor; should be required to walk about and to attempt all the various motions, to determine whether the column is rigid or not. An examination should be made as to the flexibility of the spine. The child should be laid flat, face downward, on a table while a surgeon places his hand on the child's back, and grasps both feet in the other hand, raising them from the table and attempting to flex the spine backward as far as possible. If the vertebræ are inflamed the column will be retained in a rigid position and it will be found that only very slight flexing, or none at all, will take place, and that the patient comes up stiff from his hips to his shoulders. On the contrary, if there is no disease present there will be very marked flexibility of the spinal column so that there is a decided curve as the limbs are raised from the table. Suspension should always be tried also. The patient should be placed in the Sayre apparatus, or should be lifted by his head as far as possible, if not entirely off the floor, so that the entire weight may depend from head and shoulders. This usually gives immediate relief.

If the patient has been suffering from difficulty of respiration one marked feature may be the relief experienced in this respect. Where before the suspension the patient's breathing was accompanied by a

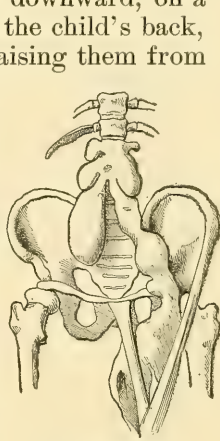


Fig. 214.  
Lumbar and Psoas  
Abscess.



Fig. 215.  
Lumbar Ab-  
scess.

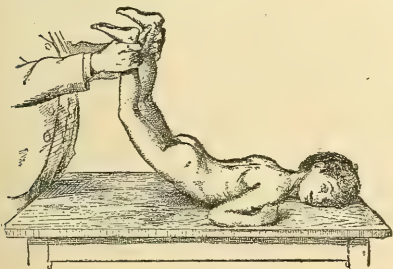


Fig. 216.  
Examination of Normal Spine.

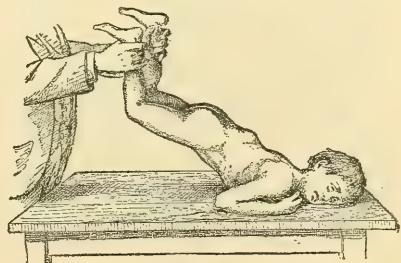


Fig. 217.  
Examination for Flexibility of Spine.

grunting sound, when he is suspended the breathing becomes free and easy and he evinces signs of relief from pain. This is explained by the fact that the pressure is taken off the inflamed vertebræ, and as it is removed the patient is relieved of the aggravation caused by each excursion of the ribs and shows it by his easier breathing, and frequently by stopping the crying or shrieking which has accompanied the previous portion of the examination. The patient should also stand on a chair or table and slight pressure be made downward on the top of the head to see if the pain is increased or not. Pressure should be made on the ribs to ascertain if they articulate with the inflamed vertebræ; if they do this will cause pain at the junction of the ribs and the

vertebræ. Where a greater progress of the disease has been made and a deformity is present the diagnosis is of course easy. The diagnostic points which are given in connection with hip-joint disease, for diagnosing between disease of the lower vertebræ and disease of the hip-joint by examination of the flexibility about the joint, should also be carefully tested. The surgeon must be careful in making a diagnosis to eliminate tumors, when the history and physical signs will generally be sufficient to lead one to a correct differentiation. Empyema will be distinguished by physical signs, the history and local symptoms. When abscess is present and in the inguinal region it has some points in common with the inguinal hernia. The presence of a tumor at the usual point of a hernia with the cough impulse may lead one to suspect that this condition may be present; but other symptoms, and especially the history of previous Pott's disease, will lead to a correct decision.

**Prognosis.**—A large number of cases of Pott's disease of the spine get well spontaneously but there is likely to be a deformity of very marked degree, and the object of treatment is not only to decrease the proportion of mortality, but to prevent as far as possible the deformity from becoming progressive, and also to save the patient the severe pain which accompanies the course of the disease. It is probable that under proper treatment the severe varieties of deformity can be prevented. More or less deformity may necessarily accompany the absorption or disintegration of the bodies of one or more vertebræ, but hunchback and severe forms of angular curvature may be avoided. If the patient recovers there may be ossification of the diseased portion and complete ankylosis of several vertebræ; if an abscess is present it may end in a residual abscess and finally undergo calcification.

**Treatment.**—In the treatment of these cases the first thing is to relieve the pain from which the patient suffers, and the easiest and quickest way to accomplish this is to immobilize the spine. This can be done by means of braces or by one of the various forms of jackets made of plaster of Paris, leather, felt, wood or paper. The most convenient and easiest method is the use of the plaster of Paris jacket, because it is easily applied, is cheap, adapts itself immediately to the form and can be more quickly obtained than any other form of apparatus. The plaster of Paris jacket was re-introduced a number of years ago by Sayre and has been almost universally adopted in the treatment of these diseases, having been found very effectual. For the application of the plaster of Paris jacket the patient should be suspended in the Sayre apparatus sufficiently to take the weight off the spine. In small children they can be suspended so that the feet do not touch the floor, but larger children, where the pressure on the head and under the arms would be too great, may be allowed to balance themselves on their toes (Fig. 218), taking as much pressure as possible off the column. The patient should have a very close-fitting knit shirt which will accommodate itself perfectly to all the curves of the body, so that there be no wrinkles, and in order to put it on the stretch weights should be attached to the bottom to draw it down as tightly as possible. In the directions given in most works of orthopedic surgery it is stated that a padding over the hips and the prominences should be placed directly against the skin underneath the shirt, but the author believes this to be a mistake. If



the cotton or wool padding which is used is placed over the shirt and between that and the plaster of Paris bandages it remains in position and is quite as efficacious as though placed underneath. All prominences should be well guarded, because, in spite of the fact that the jacket may be a perfect-fitting one, there will be more or less shifting and the skin is apt to be rubbed away from the bony prominences. If there are abscesses which are discharging at a point where the jacket would cover the opening, provision should be made for the discharge, and if a small piece of cardboard, about two inches in diameter, with a pin sticking through the center is placed directly over the sinus and left in this position while the bandages are being wrapped around the patient the point of the pin will act as a guide for the finding of the cardboard. In order that the head of the pin may not be driven into the flesh it is well to place another small piece of cardboard between it and the skin. After the jacket has been applied the plaster

may be cut away sufficiently for the cardboard to be removed, then the edges of the cut plaster are made waterproof by means of shellac or a solution of rubber tissue in chloroform, and the discharge caught on some form of dressing and removed as often as necessary.

While the patient is suspended the plaster of Paris rollers are placed in a dish which contains sufficient water to just cover them; only two or three bandages should be placed there at a time, that one or two may be soaking while one is being applied. The surgeon begins at the hips and passes the bandages rapidly round and round the body, each turn of the bandage overlapping the one which preceded it about two-thirds. Occasionally one or two strips should be made to run diagonally from the shoulder to the opposite hip, or crosswise, to bind the different layers together, because if this is not done the jacket will sometimes split or break in two. Another way which may be employed is to use strips of zinc or tin which have been perforated with a punch, leaving rough surfaces.

These are laid between the layers of the plaster and answer the purpose of tying the layers together, and also stiffen the jacket so that not so much plaster of Paris is required. As the bandages are being applied an assistant should rub the plaster well into the bandages so as to firmly knit all the different layers together, additional plaster being applied from time to time as it may be needed. The advantages of the plaster of Paris jacket are its cheapness, its ease of application, its perfectly fitting shape and its rigidity. In case of Pott's disease the plaster of Paris jacket should not be opened, but kept perfectly solid. The object of this is to prevent as far as possible the excursion of the ribs in breathing,

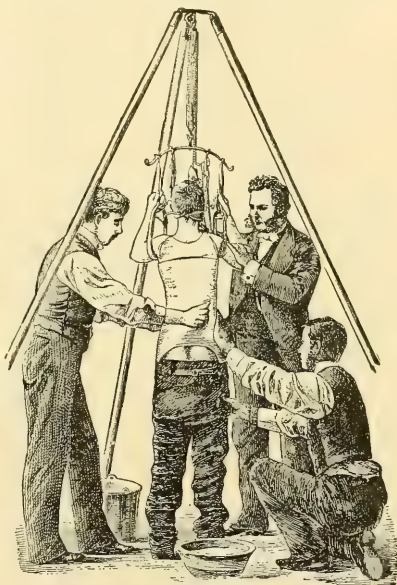
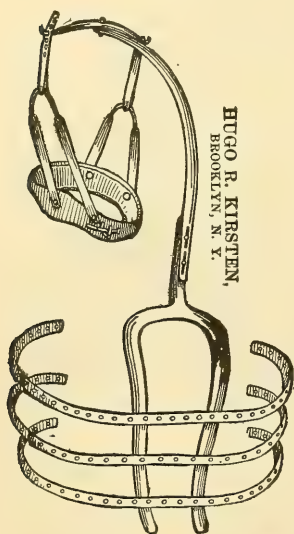


Fig. 218.

Method of Applying Plaster of Paris Jacket.

maintaining the chest in an immobile position. The patient is able to breathe sufficiently in the upper portion of the chest and the abdomen so that the movements of the chest are not absolutely requisite. One provision which must always be made is for the increase in size after meals, and for this purpose what is known as a "dinner-pad" is placed underneath the shirt upon the stomach of the patient while the plaster is being applied. This is to be removed during the process of drying.

In some cases it is impossible to suspend the patient for application of the plaster of Paris jacket. In such a case a strip of strong muslin may be stretched lengthwise over a frame. This should be as long as the patient. The patient is laid flat, face downward, on the muslin, which should then be slit down alongside and close to the body. Then, while the patient is kept in this position, the plaster bandages are wrapped round the patient, passing through the slits and enclosing the portion of the muslin on which the patient is lying. This procedure is of importance as a last resource. If there is disease in the cervical vertebrae or in the cervico-dorsal region the plaster of Paris jacket does not answer the requirements sufficiently in itself and the surgeon has to add some form of head support, the best of which is the "jurymast." (Fig. 219). The base of this is embedded in the layers of plaster of Paris during its



HUGO R. KIRSTEN,  
BROOKLYN, N. Y.

Fig. 219.  
Sayre's Jurymast.

application, and the curved portion or head-piece may be screwed on afterwards. The plaster of Paris jacket has a few objections. In warm weather it is likely to become soft from perspiration of the patient's body, and on account of not being able to remove it, the secretions from the skin are likely to cause irritation; again, it sometimes becomes exceedingly filthy, especially where cases are not well taken care of, and it is impossible to clean it effectually. However, it is the only form of apparatus which can be used in some instances. The leather, the rawhide, the paper and the wood corsets have certain objections: they are generally made so that there is very little chance for ventilation, being very close and likely to cause more or less excoriation of the skin unless they are removed quite frequently, and the removal of any form of apparatus is open to serious objection. The felt jacket, which is more porous, is also likely to become softened in hot weather. Within the last few years the author has found more satisfactory results from the use of a modified "Taylor's" brace than any other form of apparatus. This brace is easily applied, the jurymast may be added to it with very little difficulty, and it has the advantage of being much better ventilated than any of the forms of jacket. It is also lighter, and in the author's hands has given excellent satisfaction. Whatever form of treatment is adopted the immediate object is the complete immobilization of the spine to prevent the functional hyperemia, diminish the inflammation and secure relief from pain, and these can-



not be accomplished without some form of apparatus. The forms which have already been mentioned are the most satisfactory.

While the brace is, on the whole, more satisfactory, it requires much greater skill in its application on account of the difficulty in shaping it perfectly to the body. In order to do this correctly the surgeon must be an adept in bending the steel bars to make them fit into the depressions and over the prominences. If this is not done perfectly chafing and ulceration of the skin, with great pain to the patient, will surely result.

For cases of cervical caries some surgeons prefer the hard rubber chin piece, which is attached to the spur of the brace by means of a ball and socket joint, the motion of which may be limited by a set screw. (Fig. 221).

This device has not been found as comfortable to the patient or as good in its results as the jurymast with the head-piece. Objections have been made to this latter apparatus, one being that the pressure of the straps on the

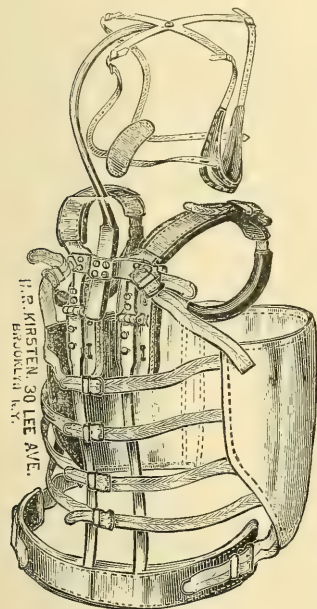


Fig. 220.

Author's Arrangement of Taylor's Brace and Jurymast with Steel Spring to Separate Straps.

sides of the face causes the wearer to bite his cheeks when chewing. This has been obviated by the use of a steel spring shown in Fig. 222, which spreads the straps apart, and at the same time keeps up an even traction.

Another improvement which has been added is the arrangement for making traction directly upward from the occiput and under-part of the jaw, instead of drawing upward and backward on the chin. This is much more comfortable for the wearer, and is less likely to produce the receding chin frequently the result of long-continued use of the single crossbar.



Fig. 222.

Author's Steel Spring for Spreading Face Straps.

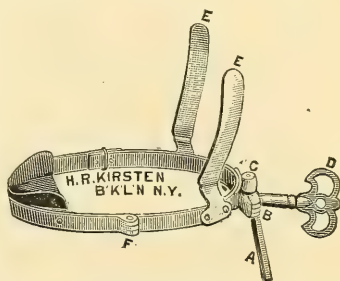


Fig. 221.

Hard Rubber Chin Rest with Occipital Support.

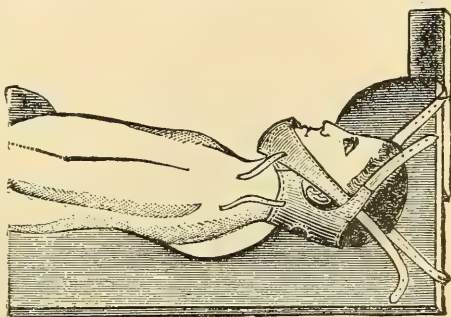


Fig. 223.

Phelps' Upright Bed. Fastening of Head to Upper End.

The application and removal of the brace with the jurymast is greatly facilitated by the use of detachable shoulder pieces.

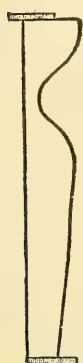


Those shown in Figure 220 may easily be made detachable or not. Sometimes still other methods are required.

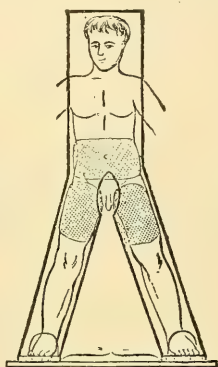
The use of the plaster of Paris bed is sometimes a very excellent method; it is illustrated in Figs. 223, 224, 225 and 226, and is described as follows:\*

One application of the principle of extension which can always be easily and cheaply resorted to is the upright bed devised by Phelps (Figs. 223 to 226), and it is an apparatus of great value in infants, particularly for paralytic cases, and for those where there exists marked curvature.

By measuring or marking an outline drawing of the child with legs spread apart, we may have constructed a wooden case with openings for the arms (Fig. 225) and for defecation; the foot-board must be about five and one-half inches high, and places for the heels are cut out, while the top of the bed is only closed at the posterior half by means of a slat.



a



b

Fig. 224. Phelps' Upright Bed (Schematic); a, Lateral; b, Front View.

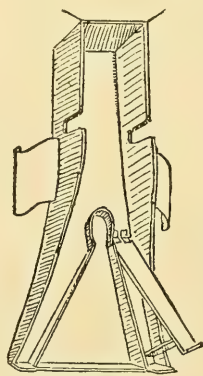


Fig. 225.

Upright Bed with Movable Leg-rests.

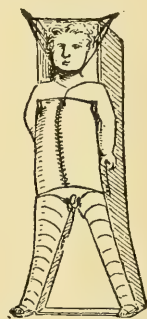


Fig. 226.

Upright Bed Containing Patient.

The case is then padded on both sides, and especially across the middle, with jute cushions; the padding is deftly covered with water-proof material, the child is laid into the case and fastened with flannel roller bandages, the head is covered by an ordinary cap or rests in Glisson's slings, the straps of which are hung to nails on the lateral wall of the case. When the strap is lifted and placed nearly or quite upright, the child is, as it were, suspended partially by the head.

As a rule children with spinal caries are bedded afresh about once a week; the legs should be bandaged anew every day and be subjected to passive motion.

Various forms of beds have been employed to effect the same object. One of the best has been constructed by Gorham, of Albany. Occasionally during the early stage it is possible that recumbency may be all that is necessary, but it is not safe to allow the patient to go for any length of time without one of the forms of retentive apparatus. In some cases, where the disease is confined to the cervical region, various forms of collars have been used; they are made of wire, felt, leather, or rubber which can be inflated; but these are of very little use, because without something about the body which

\* Schreiber in Woods' Medical and Surgical Monograph.

is firm and fixed and which will act as a base of support, collars will not retain their position and are very disappointing in their results, as they allow the head to move about more or less, and are exceedingly uncomfortable about the neck of the patient. If the disease occurs in the upper dorsal region the same variety of jurymast should be used as in the cervical; and because it is impossible to get purchase enough with the use of the jacket or brace alone something must be used which will carry suspension further up and lift the weight of the head from the inflamed part. Where the disease occurs in the lower dorsal or upper lumbar region the same form of jacket or brace can be applied with the jurymast; it is in this portion of the spine that the disease is treated with the least difficulty, because it is easy to gain sufficient pressure by means of the apparatus to avoid an increase of the deformity.

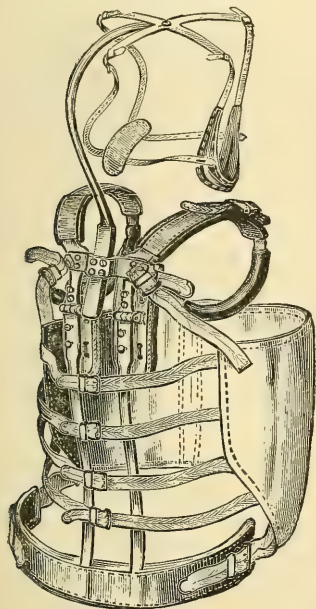


Fig. 227.

The Author's Improved Arrangement of Brace Jurymast with Four-Armed Steel Cross-pieces for Making Traction Directly Upward on Occiput and Chin.

Where the disease occurs lower down in the lumbar region the difficulty of lack of support is again encountered, and the jacket or brace must be supplemented by the addition of a long piece extending down posteriorly as far as the coccyx, in order to give a base support to the diseased portion. When the patient comes for treatment the operator should note the exact amount of deformity which is present. This may be done by means of a lead tape which is pressed carefully along the spine from the occipital protuberance to the coccyx while the patient is lying on a flat surface face downward. (Fig. 228). After pressing

the tape accurately along the spine so that it is perfectly adapted to every depression or protuberance it is then removed and laid upon a piece of stiff paper; the impression is traced with a pencil on the paper, and this can be cut out and applied to the spine for correction. Another way is to take a stiff piece of paper, or cardboard, cut the shape so that it will fit approximately to the spine, lay it on the back and by means of a compass or a pencil mark the exact shape of the spine along the edge of the paper. (Fig. 229). This is cut out and tried on to see if it is correct. From this diagram of the deformity and others made during the course of the treatment the surgeon may be able to keep an accurate record of the increase or decrease of the deformity, so that in case the child improves and the deformity decreases the progress may be noted down from time to time, it being always a satisfaction to the patient and to the

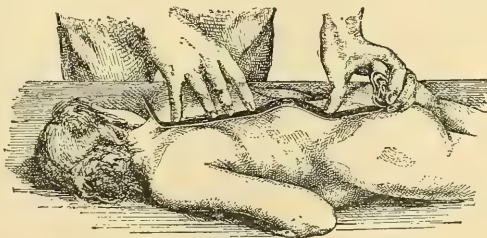


Fig. 228.

Measurement Method in Spine Disease.

physician to note accurately what the result of the treatment has been. Also this same diagram of the spine may be used in fitting the brace correctly to the spinal column so that the pressure may be obtained at the right place. There are various forms of apparatus which are used by which the patient walks about on a sort of wheel-crutch, Fig. 230, but these are exceedingly cumbersome and I think of less practical use than

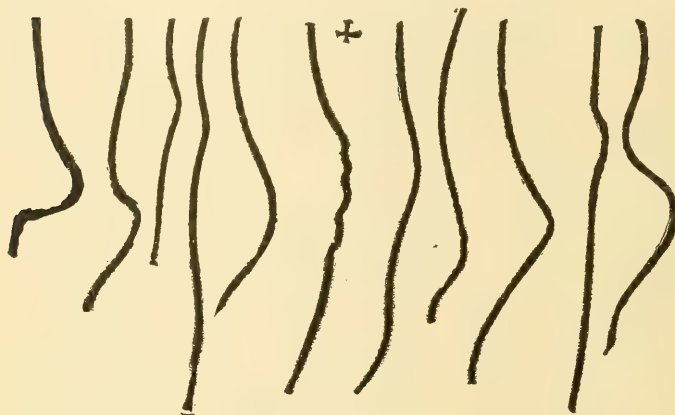


Fig. 229.  
Tracings of Varieties of Kyphosis.

the forms of apparatus already mentioned. One of the difficulties always encountered in every form of apparatus is the excoriation of the skin; this will be especially likely to occur in summer when the perspiration softens the skin and the pressure is kept up continuously. Constant care must be taken to prevent this distressing symptom; frequent changing, frequent washing of the skin with astringent solutions, and the application of soothing powders, like talcum powder, must be kept up. One of the most efficient astringent lotions is made by taking a small quantity of powdered tannin and pouring boiling water upon it; this is allowed to stand for a little while and then the solution is applied frequently to the sore spot; of course the pressure should be shifted as much as possible from the spot which is excoriated and the air be allowed to come in contact with it until it is healed.

Where there are symptom of paralysis there is a question as to how much should be done. The author's experience with a number of cases is that the retentive apparatus should be placed in position and the patient kept in bed, and it is believed that the most of these patients recover if sufficient time and proper treatment be given. With the relief to irritation and the removal of the inflammation the thickening of the peri-meningeal tissues decreases, the pressure is relieved, and, as a result, function of the parts slowly returns. The author has seen in patients, who have been for eighteen months with no use whatever of the lower limbs and no sensation, the function returning with surprising rapidity at the end of that time. Within the last few years the operation of laminectomy has been proposed and attempted, and it is still a debatable question whether it is well to perform an operation for relief of the pressure on the cord. The operation has been much discussed in the surgical societies, but as



Fig. 230.  
Wheel Crutch.



the pressure is the result of a pachymeningitis, and as the results of the operation thus far obtained have not been flattering, it can hardly be advocated as a cure for this form of paralysis. And still further, as most of these cases tend to get well under treatment, and function of the limbs may be restored without operation, it seems impracticable to perform such an operation unless imperatively called for. Where there is danger of a permanent paralysis, as shown by the fact that paralysis has existed for perhaps two or three years with no improvement obtained, then it might be considered; but where the paralysis has existed for only a comparatively short time and there is probability of the inflammatory deposit being absorbed it is better to wait for a considerable time before attempting so severe an operation. Of course remedies, hygiene, good diet, sleep, proper clothing, salt baths and massage are all necessary to keep up the general health, and should be faithfully attended to.

The apparatus, whatever it may be, should be worn until all traces of disease have disappeared and even for a time after as a precautionary measure. No certain time for recovery can be stated but it is never well to state in the beginning that it will take less than eighteen months or two years.

## CHAPTER II.

### LATERAL CURVATURE OF THE SPINE OR SCOLIOSIS.

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**Definition.**—Lateral curvature of the spine, or scoliosis, is a condition in which there is a permanent lateral deviation of the vertebral column from its normal shape, without actual disease of the vertebræ. There is a mistaken notion among the laity, also existing to a certain degree among physicians, that every person has normally some lateral deviation of the spinal column. This is supposed to be the result of using one arm more than the other, as a right curve in a right-handed individual and a left curve in one who is left-handed. It is often stated that every person has one shoulder higher than the other, and that no person is symmetrical. This the author believes to be erroneous. Every one should be symmetrically built; the shoulders should be on a level, the hips of equal size, and the limbs of equal length. Any deviation from this condition is abnormal, and constitutes, in greater or less degree, a deformity.

**Varieties.**—There are two varieties of lateral curvature: in one the curve is flexible, and the spine may be straightened at the will of the patient, or with some help from the attendant or surgeon, and will remain straight so long as the superincumbent weight is lifted from the column, or so long as the muscles of the two sides are able to retain an equal degree of contraction. In this variety there are no contracted muscles in the early stage; the condition consists simply in a lack of strength or tone of the muscles on one side, with a normal contraction of muscles on the opposite side; as a result the weak muscles give way, and the opposite muscles, acting with their usual force, have a tendency to draw the spinal column in their direction. This variety of lateral curvature may be easily corrected if prompt and careful attention be given to the conditions which lead to its existence, and the prognosis in such a case, especially if coming on after the age of thirteen or fourteen years, may be considered good, though much patience and perseverance in the treatment and careful attention to the case are absolutely necessary. The other and more serious variety is the form known as rotary lateral curvature. In this variety, while there is no actual disease in the spinal column, there is a vicious contracture of certain muscles of the spine. The author believes that Shaffer's explanation of this variety is better than any other, and that is that there exists structural shortening or contracture of some of the small inner muscles running from one vertebra to another along the spine. When this structural change has taken place the muscle is finally developed into a fibrous cord and loses its elastic properties. The muscles remain in this condition permanently. It is an unsettled question whether a flexible curve which is simply the result of weak muscles will result in a fixed curve with rotation; but there is no doubt that many cases which originally are flexible, and which might be easily treated in the early stages, end in permanent deformity. The author believes that there are cases

which have the tendency to take on the structural change from the first, and it is very doubtful whether this tendency to contracture can be prevented. In the one case there is the condition which can be remedied and the patient restored to symmetry, while in the other there is a condition which is from the first vicious in its tendency, and which tends toward ultimate and unchangeable deformity.

**Etiology.**—Lateral curvature may be either congenital or acquired, but the former variety is very rare. It is from five to eight times more frequent in girls than in boys, and most frequently appears at about the age of puberty, although it sometimes occurs in very young children and occasionally in middle life. In the ordinary cases of flexible curve the patients are usually young girls who are not strong, and who seem to lack vitality. They have poor appetites, are pale, frequently menstruate profusely, and show a general lack of systemic tone. As a rule they are not inclined to take much exercise, or, if they do, it is only at irregular intervals; they become easily tired and suffer from headaches and are often astigmatic. In these cases the constitutional condition is largely at fault, and by remedying this low tone of the system and correcting certain tendencies which these patients have to bad habits of sitting, standing, walking, etc., recovery is possible. The fact that curvature occurs more frequently in girls is probably because boys by being more out of doors and enjoying more active sports and keeping up a better general condition are rendered stronger and more



Fig. 231.  
Ordinary Case of Lat-  
eral Curvature.

likely to resist the tendency to any form of deviation of the spinal column.

The other and more serious variety may occur at an early age, and the earlier it begins the more grave the prognosis. Where it exists in very young children it is frequently the result of a rachitic condition, and these cases are exceedingly difficult to treat, especially as the treatment must be prolonged over a period of years. The deformity which is apparent in lateral curvature of the spine consists in a lateral deviation of the spinous processes from the perpendicular. The curve is always named from the direction of its convexity. If the convexity is toward the left it will be known as a left curve, and if toward the right, a right curve. There may be one curve or there may be two, or perhaps more. Usually there are two curves, one of which is known as the primary and the other as the secondary or compensatory curve. The secondary curve is the result of an unsuccessful attempt to straighten the original or primary curve, for if there is only one curve the patient is likely to be ill-balanced, and there is an attempt on the part of nature to restore the equilibrium. There are a number of conditions which may act as exciting causes of what is known as the static form of lateral curvature, and among these are certain conditions of the lower limbs, as one-sided flat foot, where the arch of one foot is lower than the other, with the result that the leg on that side is practically shortened. Normally the plane of the pelvis from one iliac crest to the other should be level, but if one leg is shortened the result will be that the pelvis on that side will drop down.



This dropping varies from one-half inch to even more. A condition of knock-knee, where one leg is bent more than the other, may also be cited as a cause of static curve, and as this condition very frequently accompanies that of flat foot, the leg on one side becomes practically very much shorter than the other. Unevenly bowed legs may act in the same way.

If one side of the pelvis falls to a lower level than the other the result would be that the spinal column, which is fixed at a right angle to the plane of the pelvis would assume an oblique direction if inflexible, the weight of the patient above the pelvis would cause him to lose his equilibrium, and he would be unable to retain the upright position. However, in order to do this the spine is curved toward the opposite side, so that the head is brought again over the middle line of the pelvis, and the balance is maintained. These points should always be carefully borne in mind in making an examination of the patient, although a large proportion of cases are not a result of this condition. Not only the spine, but the entire length of the trunk, limbs and feet should be examined;

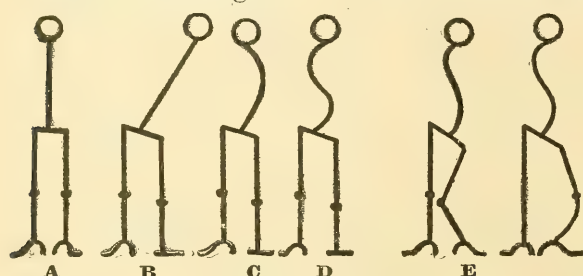


Fig. 232.

if these are neglected, and the spine alone attended to, it is impossible to remedy the curvature.

Fig. 232 represents the production of lateral curvature from one practically shortened lower extremity.

A. Both limbs of the same length; the pelvic plane is level and the spine maintains its perpendicularity.

B. One limb practically shorter from dropping of arch of one foot; pelvic plane tilted and spinal axis deflected to one side. (Of course such a condition is actually impossible, but would be possible if the spine was rigid instead of a flexible column.)

C. Same with attempt of spinal column to right itself in order to bring head over center of gravity and preserve the equilibrium.

D. Same after production of the secondary curve.

E. Similar result from one practically shortened limb from knock-knee; arches of feet normal.

F. Similar result from one practically shortened limb from curvature of bones of left (bow-leg); arches of feet normal.

A static curvature may be produced by any cause actually shortening one leg if the shortening is not compensated for by raising the foot on the affected side so that the pelvic plane is restored to the level. Such actual shortening may result from non-development of the limb from paralysis or ankylosis of the hip joint, or from loss of bony substance from disease or operation. It is usually stated in works on orthopedic surgery that lateral curvature is the result of bad positions habitually used in sitting or standing. This is true to a certain extent, but the author's belief is that these bad positions are the exciting rather than the primary causes. It would be difficult to find a person who stands up squarely on both feet habitually or who sits up straight on all occasions. The days

of the old straight-backed chair and the backboard have gone, and if positions of relaxation and ease were the primary cause of curvature there are few persons who would be straight.

In all cases of lateral curvature there is a predisposing cause in the unequal balance of muscular power on the two sides of the spine. The truth of this theory is demonstrated by the results of the treatment which consists mainly of strengthening the muscles of the weak side. Nevertheless, the elimination of one cause is as important as the other, and not only must the weak muscles be strengthened but the bad habits of lounging while sitting or standing must be corrected.

To quote from Bradford & Lovett,\* Sigfried Levy thinks there are two distinct factors in the production of habitual scoliosis; one, 'an anomaly of nutrition' a purely organic matter; secondly, certain mechanical causes—faulty positions of standing and sitting. Neither one of these factors can cause it alone; both must be present at the same time.

Certain occupations where one arm is used in excess may act as exciting causes; in children bad positions while studying, writing or at piano or violin practice.

Among the pathological conditions are "results of certain inflammatory conditions," as stated by Young;† such as torticollis, cicatrices from burns, phlegmons; caries or necrosis of the ribs, etc.; pleuritic affections, especially empyema; certain muscular conditions, as spasms, unilateral muscular atrophy and hypertrophy; muscular rheumatism (myositis), sciatica and other nerve conditions; neurotic changes, either akinetic or hyperkinetic, especially the former, of which antero polio-myelitis is the commonest example; morbid growths of the sides of the pelvis or trunk, as encephaloid or sarcoma, by their enormous weight; and sacro-iliac disease from the habitual faulty position assumed to relieve suffering. He also states that trauma is more apt to produce antero-posterior curvature than lateral, while non-reduced lateral discolation and gunshot wounds might produce lateral deformity.



Fig. 233.  
Spinal Column with Rotary Lateral Curve—Museum of New York Homeopathic Medical College and Hospital.

The actual pathological conditions which exist in an advanced case of lateral curvature may consist of a change in the shape of the vertebræ themselves; also a similar change occurs in the intervertebral cartilage. Normally the two edges of the vertebræ should be of equal thickness, but if the spine deviates from its normal position so that there is a considerable

curve the pressure is increased on the side of the concavity while it is decreased on the side of the convexity, absorption taking place. The

\*Orthopedic Surgery, p. 133.

†Orthopedic Surgery, pp. 174-175.



vertebræ and the intervertebral cartilage become wedge-shaped, the thin edge of the wedge being toward the concavity and the base toward the convexity. This will increase as the disease progresses, until finally there is such a change in the column and the vertebræ that it is beyond remedy. Another change which takes place is the peculiar rotation of the vertebræ in severe cases. Rotation consists of a twisting of the column in such a manner that the bodies of the vertebræ swing round and away from the median line towards the convexity of the curves, while the spinous processes remain nearer the median line. When rotation has taken place the line of the spinous processes is much straighter than that of the bodies of the vertebræ, so that when a patient with rotation is examined the amount of curvature which is visible is the least which actually exists. This fact should be borne in mind in estimating the actual amount of deformity. As the rotation progresses certain of the abnormal conditions present themselves as a consequence. The ribs being closely attached to the vertebræ must move more or less with them, and, as a consequence, the shape of the chest becomes changed. When viewed from behind it will be found that the ribs are more prominent on the side of the convexity and depressed on the side of the concavity. When viewed anteriorly the chest is flatter and the mammary gland smaller on the side of the convexity, while they are more prominent on the side of the concavity. Also when the ribs project backward on the side of the convexity they carry with them the scapula, the lower angle of which becomes much more prominent on that side than on the other. In bad cases the ribs on the side of the concavity are crowded together, while on the convex side they may become widely separated and even be pushed down inside the iliac crest. The most widely accepted theory of the cause of rotation is that of Judson, which is that to the bony processes of the spine are attached the muscles which control the movements of

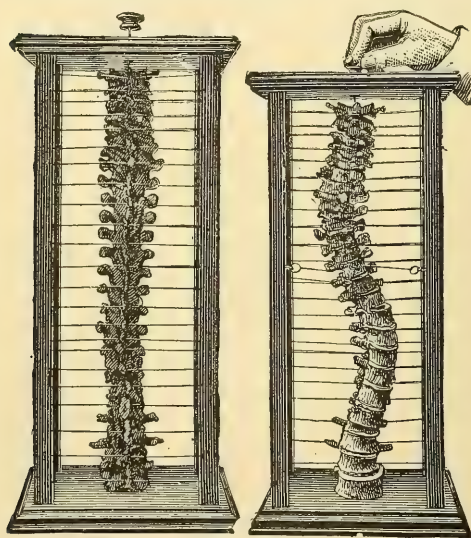


Fig. 234.

Judson's Apparatus to Explain Rotation.

tion of the foregoing statement. (Fig. 234.)

the spine, while the bodies of the vertebræ have few muscular attachments. The bodies of the vertebræ form the supporting portion of the column while the processes give no vertical support. Thus while the bodies hold up the superincumbent weight they have not the lateral support to keep them in their proper position that the spinous processes have with no weight to sustain. When there is a tendency to lateral curvature the column bends at its weakest portion and the bodies swing out of the perpendicular, while the spinous processes are held more nearly in their proper position by the muscles which are attached to them. The accompanying figure by Judson will aid in the explanation of the foregoing statement.



This figure shows a vertebral column, the parts of which are held in the upright position by a flexible steel rod, while the spinous processes are held laterally by elastic cords fastened to the side posts. Pressure downward on the top of the steel rod causes lateral curvature and rotation.

This theory of the causation of rotation when slight lateral curvature already exists is very plausible, but it does not explain why rotation should in some cases precede any appreciable lateral curve. That such a state of affairs does occasionally exist the author has been abundantly able to demonstrate by the changes in the shape of the chest and the prominence of one scapula, while the line of the spinous processes was perfectly straight. This leads the author to believe that, in some cases, the curvature is secondary to rotation, the result of some vicious contraction on the part of certain muscles and ligaments.

**Symptoms.**—The symptoms may vary from a slight deformity attended with no pain to great deformity, both lateral and rotary, and great pain, resulting from the contractures and pressure upon various organs.

Frequently the early symptoms are not at all marked. They may consist in a slight deviation of the column to one side. The first discovery is usually made by the dressmaker, who finds difficulty in fitting a dress on

account of the back seam running to one side and requiring a change of plan to bring it straight. Sometimes it will be noticed that there is a difference in the height of the shoulders or hips. One shoulder becomes much higher than the other, and, if the principal curvature is in the dorsal region, the shoulder on that side is the one which is higher. The shoulder on the side of the concavity is lower and the hip on that side is more prominent. That side of the body is also very much hollowed, while

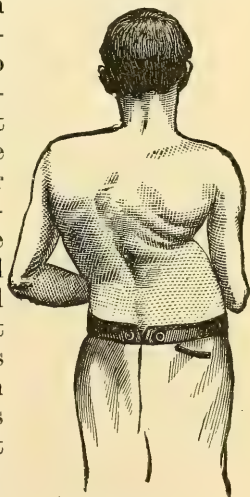


Fig. 236.  
A Bad Case of Rotary Lateral Curvature.



Fig. 235.  
Case of Fixed Curve, girl 14 years old.

the opposite side may be straight, or even convex. The deformity may increase until the spine is practically shortened, taking on almost the shape of the letter "S," so that the distance between the head and pelvis may be very much diminished. On account of the change in the shape of the pelvis the vital organs may be pressed upon, there may be severe pain, which is referable to the heart, lungs, or, perhaps, to the liver or other organs, and the patient may suffer from any variety or number of symptoms caused by pressure from the change in the shape of the chest. The cases of lateral curvature which come most frequently under the observation of the surgeon occur in young girls, and, as before stated, are very likely to be discovered by the dressmaker

in attempting to fit a garment to the child. Then a deviation is discovered in the height of the shoulders or of the hips, or, perhaps, one shoulder blade is found more prominent than the other.

Frequently, through the mistaken notion that it is simply a condition of growth or unequal development, the child is allowed to go on without treatment until the deformity becomes so apparent that the parents become alarmed and seek advice of specialists. There is no opinion which is so erroneous, or which leads to greater disappointment, than the one that these curvatures will take care of themselves, and that as the child grows older the spine will become straight. Where spinal curvature exists the tendency is always towards progress rather than decrease of the deformity, and the earlier that the case can be taken in hand the better the result will be. It is true that, in some cases, there is a spontaneous arrest of the disease, but no one can decide which way a case will terminate. When a child is examined it should be in the most careful manner and from head to foot. The arches of the feet should be carefully inspected to see that there is no flattening; the limbs and knees should be examined to see that there is no tendency to in-knee or to bow-legs, and everything which can possibly enter in as a causative factor should be carefully attended to. During the examina-

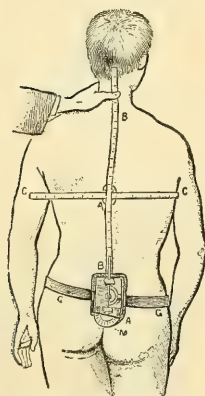


Fig. 237.  
Mikulicz' scoliosometer applied.—Reeves.

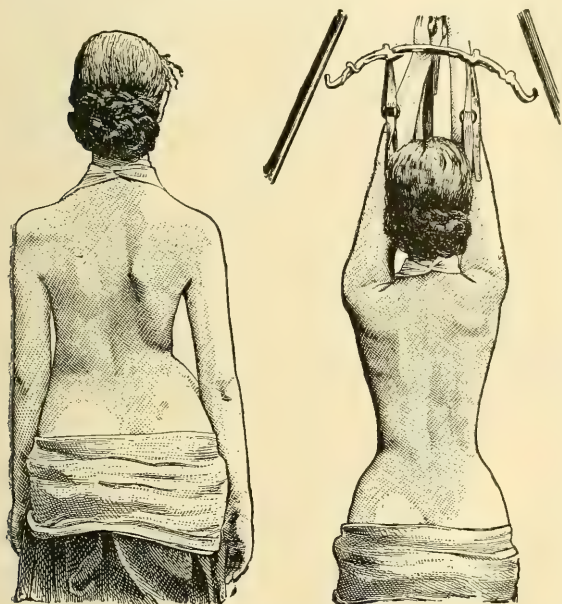
tion the child should be made to stand with its back to a strong light, so that shadows will fall equally on both sides; careful notice should be taken of the position which the child assumes in standing, of the line of the spinous processes and of any deviation of the body from the normal. It is well to take pen and ink and carefully dot the point of each spinous process; in this way it is easy to determine whether there is a slight deviation from the perpendicular or not. Sometimes, in mild cases, this is quite difficult. Various instruments have been invented to show the amount of deviation, but a string fastened to the skin on a bit of plaster over the first cervical vertebra and allowed to hang down with a small weight on the end is sufficient to indicate the change from a straight line, or a more complicated instrument, like Mikulicz's scoliosometer (Fig. 237) may be used.

If there is no deviation from the perpendicular the next thing should be to ascertain whether the curve is a flexible or fixed one. If the child is made to stand with her knees stiff, to bend over forward and try to touch the floor with the tips of her fingers, the weight of the upper portion of the body then is suspended, as it were, from the pelvis, instead of resting upon it. The result will be, in the case of a flexible curve, that the spine straightens out of itself, and all the abnormal conditions which were present while the patient was in an upright position disappear. If, on the other hand, it is a fixed curve, with contracture of the muscles on the side of the concavity, the curve may be lessened, but will not entirely disappear, nor does the projection backward of the ribs of the scapula disappear. Another test is by the use of Sayre's suspensory apparatus. If the child is placed in this apparatus and drawn up so that the weight hangs from the shoulders and head, allowing the weight of the body and



limbs to act as a counter-extension, in case of a flexible curve the deformity disappears entirely; in case of a fixed curve the deformity may materially diminish, but does not entirely disappear. All these points

must be carefully taken into consideration in making the prognosis; or where the case is one of flexible curve the prognosis may be considered favorable as a rule, but where the deformity does not disappear great caution must be observed in predicting a favorable termination. It must be borne in mind in making the prognosis of a condition of this sort that without treatment the tendency of the disease is always to get worse; but in case the general nutrition can be improved and the curve is flexible, and if proper methods be instituted, a complete cure may be expected.



Figs. 238 and 239.

Showing Effect of Suspension in Flexible Curve.

**Treatment.**—When a patient with lateral curvature is brought to the surgeon the parents or guardian should be impressed with the fact that it is absolutely necessary that the treatment should be persistent, and that it may take a considerable period of time to restore the patient to a perfect condition. If for any reason, from negligence or carelessness or laziness on the part of the parent or guardian, the treatment is omitted or not systematically carried on they may as well understand at once that there is no use in attempting to do anything. One fact peculiar to this variety of deformity is that as it occurs in children who are not strong, and as it is the result of lack of strength, the very exercise and

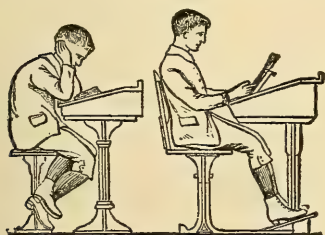


Fig. 240.

Faulty and Correct Position in Reading.

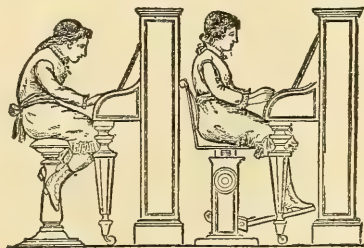


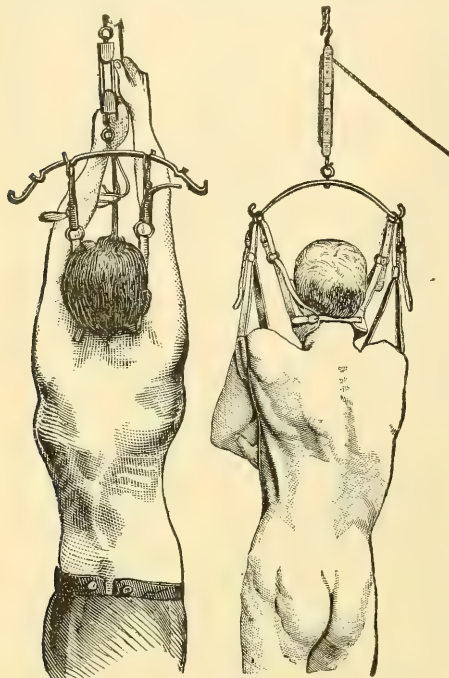
Fig. 241.

Faulty and Correct Position at the Piano.

methods which are used to correct the deformity are likely to become exceedingly tiresome and distasteful to the patient, because they require a certain amount of muscular effort, and it becomes necessary to use good deal of will power to overcome this distaste for physical exercise. On



the other hand, if they have the opportunity, these patients will frequently spend hours in dancing or other amusements under the stimulus of excitement, music, etc., while exercise morning and night with no apparent immediate object in view is almost invariably shirked; indeed, unless careful watch by the parent or guardian is instituted, and all the



**Figs. 242-243.**  
**Showing Effect of Suspension on Cases**  
**of Fixed Curve.**

force of a strong supervising mind is exerted, the treatment will soon be discontinued, resulting in disappointment to patient and surgeon. There is probably no class of abnormal conditions which come under the charge of the specialist in any disease which requires so great an amount of perseverance as the variety under consideration.

If it is found on examination that the child has any deformity of the limbs or feet these should be remedied first of all; the depressed arch of the foot should be raised and the anterior tibial muscles strengthened; if there is knock-knee it should be attended to and the legs straightened, if possible; or, if that is not practicable, the foot should be sufficiently raised so that the plane of the pelvis is made level. From the first, careful attention should be paid to diet, to nutrition, to remedies and to the general habits of the patient. If she has been allowed to eat

irregularly and of improper things this should be at once stopped; if she has been allowed to sit in bad positions and stand in slouching or drooping attitudes she should be corrected. It is always well to inquire into the way in which a child sits at her studies, at the piano, or reading (Figs. 240, 241). Almost all the patients afflicted with spine curvature are those who are exceedingly fond of sitting curled up in luxurious chairs; if they sit at the piano or desk they are likely to sit with the shoulders drooping and bent over and always in a more or less reclining position. One fact should be borne in mind in this connection, and that is that many of these children have, perhaps, an undiscovered astigmatism; they may be myopic and in order to get a better view of their music or of their books they bend over them, the condition of the eyes thus tending to increase the abnormal condition of the spine. Another thing, frequently children who are thus affected are those of very sensitive organization, in whom the artistic tendencies are highly developed. Such children are frequently passionately fond of music; some are exceedingly fond of drawing, painting, etc., and their vitality is apt to be used up in the pursuit of the pleasure which they gain from close application to musical or other artistic studies. Sometimes it is absolutely necessary that these applications be given up for a time, just as it frequently happens that those children who are

unusually brilliant mentally and exceedingly precocious in school work may require to be entirely removed from school, to allow their minds, as far as possible, to lie fallow for a time. All of these points are exceedingly necessary to the successful carrying out of the treatment of a case. The meals of a patient should be regulated, plain, wholesome diet prescribed, with plenty of fruit, vegetables, meats, and, following rather in the line of Frothergill, the author is inclined to believe that butter and oil



Fig. 244.  
For Correction of Flexible Curve.

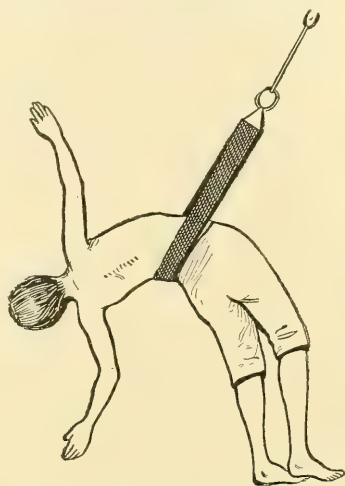


Fig. 245.  
For Correction of Flexible Curve.

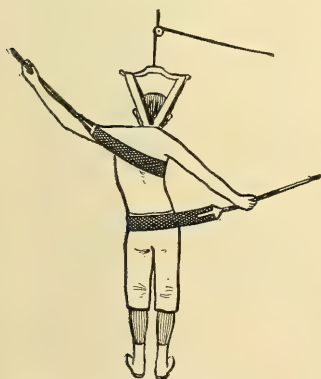


Fig. 246.  
For Correction of Flexible Curve, modified to suit each case.

First. Lying on back; arms by the sides of the body; palms upward; slow, deep inspiration by the nose; slow expiration by the mouth. Repeated four times.

Second. Similar exercise with the arms extended upward by the sides of the head. Repeated four times.

Third. Same position as first; head-rotation on axis to right and left alternately; also lateral flexion of head to right and left alternately. Repeated four times.

Fourth. Lying on back; simultaneous circumduction of both shoulder joints from before backward; elbows and wrists kept extended. Repeated twelve times.

are very excellent articles of food. In cases of flexible curve it is almost unnecessary to use any form of apparatus. Carefully instituted exercise may be entirely sufficient to remedy the curvature, and the use of galvanism, or even faradism, to the back is also an excellent adjuvant. Of course, all of these agents must be skillfully and carefully applied. The exercises, should be such as have a tendency by their action to rectify the curve, and careful study should be made of each individual case, to see what the effect of each motion is upon the patient. The following system, prescribed by Bernard Roth, is excellent and may be

Fifth. Lying on back; one hip circumduction both ways; knee kept extended. Repeated ten times.

Sixth. Lying on back; simultaneous extension of arms upward, outward and downward, from a position with the elbows flexed and close to the trunk. Repeated four times.

Seventh. Lying forward; one hip circumduction both ways; knee kept extended. Repeated ten times.

Eighth. Sitting on couch, with back at an angle of forty-five degrees; ankle circumduction down, in, up and out, while the toes are directed inward the whole time. Repeated twenty times. Also, foot adduction, patient resisting; abduction, surgeon resisting. Repeated eight times. For flat-foot.

Ninth. Lying on back, with arms extended upward by the sides of the head; flexion of both arms, surgeon resisting by grasping the hands, followed by extension, patient resisting. Repeated six to eight times. (The patient's knees, flexed over the end of the table, fix his trunk.)

Tenth. Patient astride a narrow table or chair without back, with arms down and hands supinated; trunk flexion at lumbar vertebrae, patient resisting slightly, followed by trunk extension, surgeon resisting by his hand against back of patient's head. Repeated six to eight times.

Eleventh. Patient, with arms extended upward, stands with head, back and heels against a vertical post with pegs on each side, which he grasps. The surgeon gently pulls the patient's pelvis forward by his hands on the sacrum, patient resisting, and then the patient moves back the pelvis to the post, surgeon resisting. At no time are the patient's heels to be raised from the floor. Also pelvis rotation on its axis to right and left alternately, surgeon resisting with his hands on each side of the pelvis. Repeated six to eight times.

Twelfth. Lying on back, with head and neck projecting beyond the end of the table; arms by the side of the body, palms up; the head is gently flexed by the surgeon's hand on the occiput, patient resisting, followed by head extension, surgeon resisting. Repeated eight times.

SUBSEQUENT HOME TREATMENT. To keep up the improvement and to prevent any relapse in a cured case it is important to continue to enlist the patient's co-operation and interest in his or her own case on ceasing treatment; and for the last ten years the author has been in the habit of giving patients on leaving a written home prescription of movements, of which the following is an average example:

*Final Home Prescription of Exercises:*

One. Lying on back; arms by sides; palms upward; slow, full inspiration by the nose; slow expiration by the mouth, four times.

Two. Sitting astride a chair, with the arms directed upward by the sides of the head and holding a stick, or as in one; trunk lumbar flexion and extension; also trunk rotation on its axis right and left, six times.

Three. Same position as one; head rotation on axis to right and left; also head lateral flexion right and left, four times.

Four. Lying prone on the ground; heels fixed by pressure on them; arms as in two: trunk-raising (extension) and flexion; also front rotation on its axis right and left, six times.

Five. Same position as one; one hip circumduction both ways;



knee kept extended, ten times (a shot weight of five to ten pounds is attached to the foot to increase the severity of the exercise).

Six. Lying on back; slow simultaneous circumduction of both shoulder-joints from before backward; elbows and wrists extended twelve times.

Seven. Lying prone on ground; heels fixed by pressure; trunk kept raised from ground (extended); simultaneous extension of the arms upward, outward and downward from a position of elbows flexed and close to the trunk, four times.

Eight. Standing with back against door, arms directed upward, and hands grasping two pegs fixed into the door; pelvis rotation on vertical axis right and left, ten times; also the hanging with the feet raised off the ground and the sacrum kept touching the door, four times.

Nine. Lying prone; one hip circumduction both ways; knee kept extended (a bag of shot, weight of five to ten pounds, is attached to the foot to increase the severity of the exercise).

Ten. Walking forward and backward with arms directed upward by the sides of the head and holding a stick, or arms by sides; palms directed forward, a hundred steps.



Fig. 247.  
Showing Double  
Bar for Extension  
Exercise.

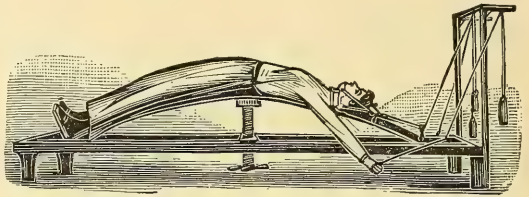
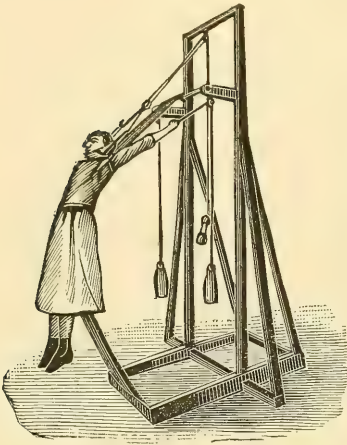
This "home prescription" is practiced for half an hour twice a day for six months, and then once a day for another six months.

In many of these exercises after filling the lungs the singing of the syllable "ah" during exhalation helps to develop the chest, while full breathing assists in forcing the ribs into correct position. Some of the author's patients have been very much benefited by daily instruction and exercise in the Delsarte system. The use of light dumb-bells, not weighing over one-half or one and one-half pounds, or of light Indian clubs, is also an excellent method of treatment, bearing in mind, however, that only such movements should be employed as have a tendency constantly to bring the spine in the correct position. The use of the double bar is good, the patient taking hold of the upper bar with the hand on the side of the lower shoulder and drawing herself up as shown in Figure 247.

The bathing of the back and limbs at night with salt water, and massage to the muscles of the back are also great helps. The Swedish movement given by a competent operator is probably the best method of applying massage.

If it is necessary to use some form of apparatus, as it frequently is with patients who are not strong enough to maintain the correct position, the best form of brace is what is known as Shaffer's, or some modification of it. The braces usually sold by the instrument makers, and which are built on an erroneous principle (Fig. 250) are of absolutely no use, in fact they are rather worse than useless, because they are mechanically incorrect, have no good effect whatever upon the curvature, and by their weight and impeding motion are detrimental in their effect rather than curative. In many forms of apparatus the tendency to tilt

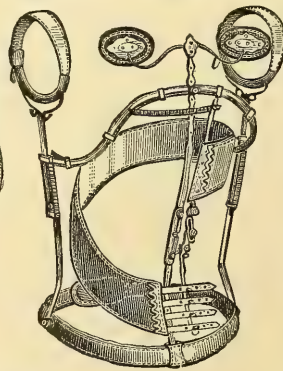
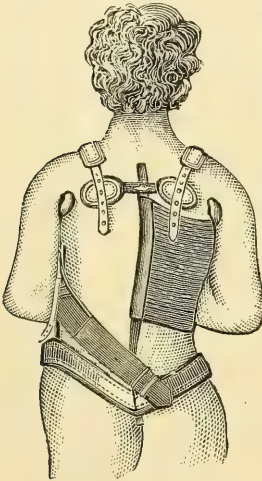
to one side from the drooping over of the spinal column is lost sight of and while, when at first applied, the patient may for a short time, maintain an upright position, after a little the sagging or the loss of strength causes the apparatus to slip up onto the large hip, and the result is that the body is pushed over one side and maintained in an incorrect position by the very apparatus which was supposed to correct it. Many of the braces mentioned are supposed to act by means of



Figs. 248-249.

Showing Methods of Exercise by Weights and Extension.

crutches under the arms which push up the shoulders; but it must be remembered, as pointed out by Sayre, that the shoulder is very movable independent of the spine, which is not affected to any degree by pushing up the shoulder. On the other hand, when the spine is straightened the shoulders become level of themselves. With Shaffer's brace (Fig. 252) much of this is remedied,



Figs. 250-251.

Stock Braces, of little use.

but it must be fitted with the utmost care, as in fact all forms of apparatus should be, and it should be constantly under the observation of the surgeon. Occasionally light corsets may be of service, and a well fitting corset made with a solid bar in the back instead of the lacing, which fits very snugly, and which has more than the usual number of steels, may be useful; to this may be added a Y shaped brace

with straps going over the shoulders, having a tendency to bring the shoulders back to the correct position. There are a large variety of shoulder braces which may have a good effect in mild cases. but it must be remembered that the action of a brace should be limited to that class of cases where the physical strength is insufficient to sustain the body in the correct position; they must simply act as aids or reminders in the treatment, the treatment not consist entirely in the use of the brace.



The following anecdote by Bernard Roth\* is full of suggestion which the author has acted upon with good results:

An eminent surgeon was consulted by a gentleman who became one of our first tragedians as to the best mode of correcting a stoop which

he had acquired. The surgeon told him that neither stays nor straps would do him any essential good, and that the only method of succeeding was to recollect to keep his shoulders braced back by a voluntary effort. But the tragedian replied that this he could not do, as his mind was otherwise occupied. The surgeon then told him that he could give him no further assistance. Shortly after this conversation the

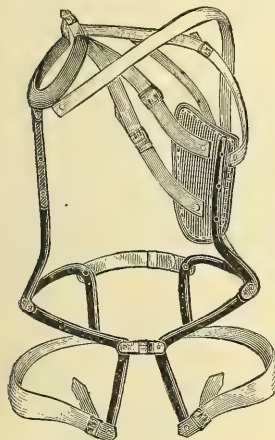


Fig. 252.  
Schaffer's Brace.

actor ordered his tailor to make a coat of the finest kerseymere so as to fit him very tightly when his shoulders were thrown back. Whenever his shoulders fell forward he was reminded by a pinch under the arms that his coat cost him six guineas, and that it was made of very fragile material; being thus forced, for the sake of his fine coat, to keep his shoulders back, he soon cured himself of the stoop. He then showed himself again to the surgeon, who ever afterward, when consulted as to whether young ladies should wear shoulder-straps, permitted them on condition that they were made of fine muslin or valuable silk, for tearing which there would be a forfeit!

A patient who has a flexible curve should always have a comfortable chair made (Fig. 255) which should be arranged so that he can read, write and study without leaning forward or turning himself, and a chair with a good solid back which leans back slightly, with broad arms which are sufficiently high that when the elbows are placed upon the arms the shoulders are slightly raised; the arms should be slightly padded; the back and seat may or may not be padded, according to the wish of the patient.

This chair should be low enough to allow the patient to sit with the feet resting comfortably on the floor or a footstool, and should have a swing-

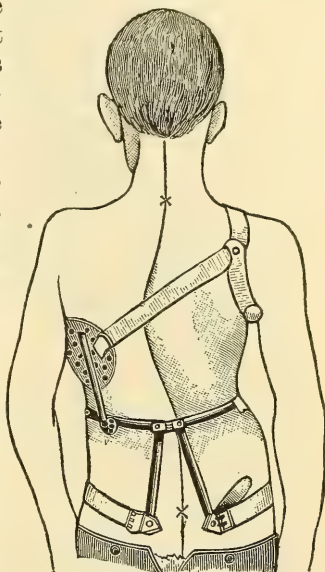


Fig. 253.  
Shaffer's Brace Applied.

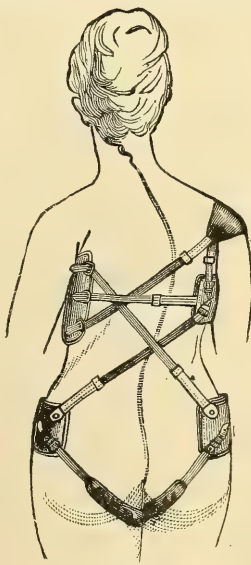


Fig. 254.  
Barwell's Arrangement  
for Making Patient Stand  
Correctly.

\*Bernard Roth, Lateral Curvature of the Spine.



ing desk so arranged that it can be changed to any position at will; and strong enough to support a book so that the patient can read without



Fig. 255.  
Reading Chair.

leaning forward. Sitting on the inclined seat of Volkman (Fig. 256) to reverse the curve is a good method of correction.

A good effect is often produced by horseback riding. Of course it is necessary to observe the effect of the position in the saddle on the curvature, and to have the saddle so made as to reverse the curve. The patient not only gets the effect of the position on the curvature, but also the benefit of the stimulation from the air and exercise on the general health. The patient should be taught to sleep on a good mattress with a low pillow. He does not need to be uncom-

fortable, but the pillow should be sufficiently low so that when the child lies on the back he is nearly in a straight line.

Riding a bicycle gives exhilarating and invigorating exercise, and is good in its general effect.

In the treatment of cases with a fixed curve the condition is much more complicated and difficult; we have to overcome rigidity of the contracted muscles, as well as the simple abnormal position of the body, and in these cases exercises alone are of very little value. The first thing to be attempted is the stretching of the affected muscles, and for this purpose some form of apparatus must be employed which has sufficient power, and which can be applied in such a position that it has the effect of constantly putting these muscles on the stretch. As before stated, the ordinary stock braces sold by the instrument makers are of very little use. Probably the most efficient agent is one of the forms of jacket which can be molded to the body. These are placed in position while the patient is suspended in Sayre's suspensory apparatus, so that the weight of the body and the limbs has a tendency to drag down and straighten out the spinal column simply by the weight. In Germany some surgeons in order to overcome an involuntary, or supposed involuntary, contraction of the muscles, have advocated chloroforming the patient in this position. This seems to be an exceedingly dangerous procedure, because it is well known that when chloroform is administered the patient should always be placed in position with his head as low if not lower than the body, and dangerous syncope or sudden death might be the result of the suspension of the patient under chloroform. It should always be remembered that the patient should never be allowed to use the suspension appa-

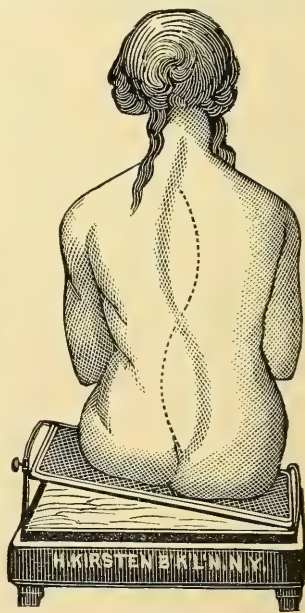


Fig. 256.  
Volkman's Inclining Seat.

ratus when alone, as cases of fatal results have occurred where the patient has become entangled in the apparatus, and, becoming unable to ex-

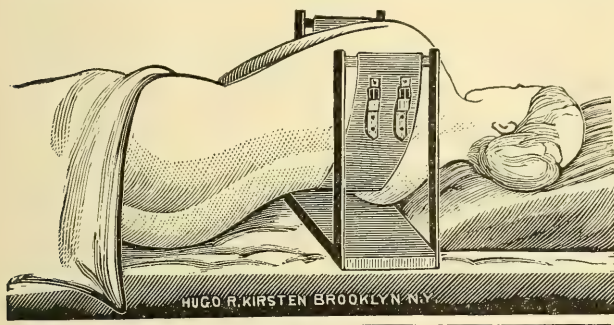


Fig. 257.

Canvas Cradle for Correcting Curve while Sleeping.

tricate himself, has expired before assistance could be had. During the suspension of the patient the plaster of Paris jacket may be applied according to the method of Sayre, and this may be used as the apparatus for carrying on the treatment, except that, instead of keeping the jacket constantly applied as in cases of Pott's disease the jacket is slit up the front and arranged with lacings and eyelets, so that it can be removed each night. This allows the patient to be thoroughly cleansed, and is more healthful than if worn constantly. The objection to this form of jacket is that it has to be renewed frequently, it is heavy, is likely to crack, and is also affected by perspiration in hot weather. Another form of jacket can be made of heavy felt which may be softened by the action of steam or of heat, and applied to the body of the patient while soft—as advised by Tivy\*—but as the patient is apt to be burned by the application of the hot felt, the author's own method is believed to be better. This is as follows: First a cast of the body should be taken in plaster of Paris while the patient is suspended, and from this a solid plaster mould is made on which to shape the felt. This method is better than any other, but instead of using felt, which becomes softened and out of shape in warm weather, sole leather is preferable, being much more resistant and easily made very hard and stiff. The jackets can also be made of rawhide, which is shaped on the cast while soft and afterwards varnished. The writer's preference is for the sole leather, because after the rawhide has been varnished its shape cannot be changed. After a plaster cast of the body is taken it retains all the deformity which remains while the patient is suspended, when it is wished to improve the shape of the body and to correct rather than retain the old deformity.

Therefore, the author has adopted the method of changing the shape of the cast as frequently as can be borne, while with a chisel or an ordinary carpenter's drawing knife the plaster is cut away on the side of the convexity and more added to the side of the concavity. It is also cut away from the enlarged hip and the prominent shoulder blade, and filled in on the opposite sides correspondingly. In this way the shape of the cast is gradually changed from one which contains all the original deformities to one which becomes as nearly as possible perfect in shape. The leather can be softened by soaking in cold water for a number of hours, and can then be nailed directly on to the cast while wet. It requires a little cutting and some piecing to fit it accurately over the prominences of the body, but after it is dry it makes a very stiff and perfect corset. (Fig. 258).

\*Lateral Curvature of the Spine, by Wm. James Tivy, F. R. C. P.



It should never be so tight across the bust as to prevent the development of the breasts and should always be padded with soft felt inside over the hips. Small holes should be punched through at intervals, or the holes of the nails with which it is fastened on the cast may give sufficient ventilation.

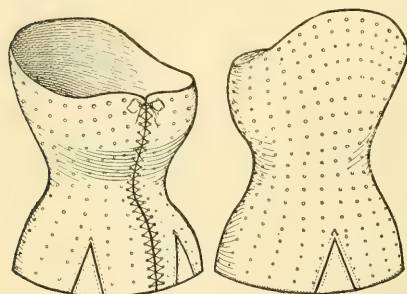


Fig. 258.  
Author's Leather Jacket.

jacket may be soaked in water, and the shape changed according to the improved shape of the cast; in this way much improvement may be obtained in the condition of the patient. The only objection of course is that the wearing of the stiff jacket prevents the expansion of the lungs and is less likely to admit of rapid development of weakened muscles, though this is counter-balanced by the improvement obtained in the condition of the patient, and by the fact that the deformity is retarded if not cured. The jacket should always be removed at night and massage applied to the muscles. There are a great number of braces which are used. Shaffer's brace has been used extensively by himself, Taylor and others, but it is too elastic, and the author has not seen good results with it in this class of cases. In these severe cases Bradford recommends the apparatus shown in Figs. 259 and 260 for forcible correction.

In some cases it is almost impossible to prevent the advance of the disease no matter what means are attempted; it seems as though the vicious contraction of the muscles absolutely prevents any possibility of a cure; but still it is always best to try, and cases after three or four years have been so improved, although impossible to obtain an absolute cure, that by the art of the dressmaker the dresses are so arranged that no casual observer would detect that a curvature existed.

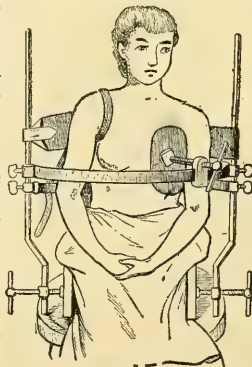


Fig. 259.  
Bradford's Apparatus  
for Forcible Correction  
of Scoliosis.

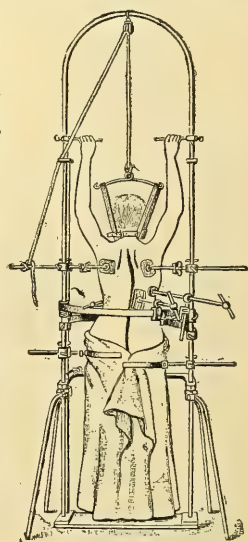


Fig. 260.  
Patient in Position  
Correcting Apparatus.



### CHAPTER III.

## TREATMENT OF TUBERCULAR ABSCESES.

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**Definitive Considerations.**—As the practice of orthopedic surgery requires the surgeon to give a large part of his time to the treatment of the tubercular or so-called “cold abscesses,” and as these abscesses are similar in character wherever they occur, it is thought best to devote a separate chapter to this subject.

Perhaps it may be well to consider for a moment what a tubercular abscess is. By the general term abscess is understood “a circumscribed collection of pus;” but to have pus we must have the presence of pyogenic bacteria, and active local or systemic disturbance in proportion to the area involved or the activity of the infecting agent.

**Symptoms.**—The symptoms of acute abscess are all well known, as chill, fever and sweats, general malaise and local swelling, redness, pain, etc., with a usually more or less rapid pointing and opening of the abscess.

On the other hand, in the cold, or, as it had better be called, the tubercular abscess, about the only symptoms are those of the diseased condition giving rise to the abscess, such as some form of joint or bone disease. There may be little constitutional disturbance and locally only a soft, fluctuating swelling, which may exist for a long time, increasing almost imperceptibly, or at the most very slowly. The reason for this is that the cold abscess has not been infected by pus microbes, consequently its contents are not true pus, although there may be a close resemblance. If left alone it usually opens on the surface, its coverings being gradually thinned and eroded through.

Instead of true pus there is a cavity containing the debris of tuberculous disease. These products consist of a thin fluid, and frequently flocculent, cheesy masses of varying size. So long as the contents of the cavity are not infected with pyogenic bacteria the condition may remain indefinitely as described, but if infection does occur true pus is generated and all the symptoms of acute abscess present themselves.

If a cold abscess opens spontaneously, or is opened by the surgeon, exposure to the air is certain, and infection is almost sure to occur, unless extraordinary antiseptic precautions are observed. This shows that the opening of the abscess with the knife, as it is often done, is not only useless, but may be most harmful to the patient. If simple evacuation of the fluid is desired aspiration with the aseptic needle is far safer, although it is only a temporary expedient and not curative.

**Treatment.**—In the treatment of these tubercular abscesses three methods are advised by modern orthopedists. First, the conservative method advocated by some authors, which consists in simply leaving it alone, letting it heal up of its own accord, if it will, or allowing it to open spontaneously. These writers seem to care little for a nasty, discharging sinus, no matter how disagreeable it may be to the patient

and friends, or how bad it may smell. They go on with the hopeful idea that after a while by the use of mechanical appliances, and, perhaps, internal remedies, the patient may get well. Many cases terminate in this way, but it is after a prolonged period, and with more or less destruction of the joint, shortening of the limb and ankylosis. On the other hand many of these cases die from exhaustion. Even Bradford and Lovett\* incline to conservatism, although in cases where the pus is not completely evacuated by spontaneous opening they advocate the thorough opening and curetting of cavity and sinuses with the hope of being able to clear out the entire diseased portion and get rapid healing.

The radical method, as especially advocated by Phelps, is to make extensive incisions and scrape out all the cavity and sinuses, putting in large drainage tubes to close the cavity as much as possible and get healing by first intention.

Young,† in speaking of abscesses forming in the cases of tuberculous sacro-iliac disease, says: "When abscesses form they should be freely opened and thoroughly drained, any sequestra found should be removed and the walls thoroughly curetted, the object being to remove, if possible, all tuberculous matter. Drainage is best effected with iodoform gauze and full antiseptic precautions." It would seem that if anything of the above sort is to be done it must amount to a complete excision and include all the diseased bone.

The third and best method for cold abscesses which have not opened is, to the author's mind, the treatment by injection of a fluid containing iodoform, either in solution or suspension. Of these the ethereal solution is to be preferred. The reasons are: First, only a puncture is made through the skin. This is made aseptically, heals up immediately and does not allow of infection. Second, iodoform is placed in the cavity in such manner that the drug exerts its action directly on the lining of the cavity. The ether soon evaporates, leaving the iodoform in its pure state, which cannot so well occur when the emulsions with oil or glycerine are used. Third, the injections may be begun as early as the abscess presents itself, and there is no radical operation requiring a prolonged stay in bed or necessitating complicated dressings. Even before the abscess is apparent iodoform in oil may be injected into the capsule of a tuberculous joint or into the tissues about the joint. Fourth, while all cases are not cured the majority are, and much more quickly than by the use of the appliances alone.

Iodoform exerts a specific action upon tuberculous tissue, and many experiments have been made to determine its exact method of action; but exactly what this is has not quite been determined. Of its effects Senn (‡), in reviewing the results of the researches of Troje and Tangl, says: "Their investigations have led them to the practical conclusion that iodoform is a true disinfecting agent as far as the tubercle bacillus is concerned; that it has a direct destructive effect upon the bacillus if left sufficiently long in contact." Further reviewing the clinical results observed by Bruns and Nauwerk (265)‡: "They incised tubercular abscesses treated by iodoform injections at different intervals after the injection and extirpated pieces of the abscess wall for microscopical examination. A few weeks

\* Orthopedic Surgery. Bradford and Lovett, pp. 323-324.

† Orthopedic Surgery—Young, p. 62.

‡ Senn on Tuberculosis of Bones and Joints, p. 249. —Idem, 265.

after injection they found that the tubercle bacilli had disappeared, the milliary tubercles softened by infiltration with round cells and edematous inhibition of a serous fluid. Further on the tubercles disappeared by fatty degeneration of the cells and liquefaction of the cellular detritus. Hand-in-hand with the degeneration and liquefaction of the tubercular product could be witnessed in the adjacent tissues a process of repair, in the shape of a wall of granulation tissue, which formed a line of demarkation between the healthy and diseased tissue, which consumed in part the dead, sterile, tubercular tissue and detached the balance. As soon as the dead tissue was disposed of by absorption the granulations began to cicatrize, and were gradually converted into connective tissue, and with this change the process of the healing was completed. Krause made similar examinations and corroborates the observations made by Bruns and Nauwerk. That the curative effect of iodoform in the treatment of tubercular joints and abscesses is not owing to the mere puncture and evacuation, but is brought about by the specific action of iodoform on the tubercular products, there can be no doubt, as tapping for these conditions was employed long before iodoform was used in surgery, but this procedure seldom yielded more than temporary relief."

In conclusion Senn (\*) says: "Of all substances now employed in this method of treatment iodoform has yielded the best results. The curative effect of iodoform in the treatment of local tuberculosis is due to its anti-bacillary effect and its stimulating action on the healthy tissue adjacent to the tubercular product."

It is not necessary to quote authorities further, for the literature of the subject is far too extensive. The question now arises: Which is the best method of getting the iodoform in contact with the diseased tissue?

Many writers object to the use of the ethereal solution from fear of danger. It may be that the bad results which have come from the ethereal solution have come from an improper method of administration, probably leaving the ether in the cavity and giving no vent. Senn (†) states the accidents which have occurred, and other authors have evidently formed opinions from reading his writings, though without actual experience, as for instance (‡): "The ethereal solution should never be used, as it is liable to cause necrosis of the over-lying tissue and iodoform intoxication."

The author is not particularly strenuous regarding the exact way in which the iodoform is conveyed into the abscess cavity, provided it gets there and does its work. But in all the cases in which he has used this injection he has never yet had a bad result. He has used it in all sorts of places, as in hip-joint abscesses, cervical abscesses and abscesses from "Pott's disease," which have pointed in various parts of the body. One of them had sinuses in both groins, and the solution could be injected into one groin and would come out the other, the sinus passing down back of the peritoneum and probably behind both psoas muscles. In another case the abscess had opened spontaneously into the rectum. The sphincter was dilated, a catheter passed up into the sinus and the cavity injected several times, with excellent result. In the place of ether Billroth used glycerine to hold the iodoform in suspension. Olive oil gives better

\* Idem, 264-265.

† Transactions Am. Orthop. Assn. 1893, Vol. VI, p. 43.

‡ Tuberculosis of Bones and Joints, pp. 262-263.



results, and is preferred by most surgeons. But it must be remembered that glycerine and olive oil only hold the powdered iodoform in suspension, while ether holds it in solution. Any one who has dissolved iodoform in ether knows how rapidly the ether evaporates, leaving a perfect coating of iodoform on the surface of everything it has touched.

In order to keep the iodoform in the abscess cavity the oil or glycerine must remain with it. If the ethereal solution is used the ether vaporizes and evaporates rapidly, leaving the pure iodoform in contact with every portion of the cavity. This seems to be a more perfect and thorough method of application than the other, and to avoid any danger from over-distension of the cavity the ether vapor is allowed to escape through the canula.

With the iodoform and the oil injection the cavity is first drained of its contents and then washed out with a four per cent. solution of boracic acid, all the flocculent masses are removed, even if the opening has to be enlarged. Then a ten per cent. emulsion of iodoform in sterilized olive oil is injected, not more than one-half drachm of iodoform being injected at one time. (\*). The opening is sealed with a pledget of antiseptic cotton and iodoform collodion. This process may be repeated as often as every two weeks until the case is cured.

In using the ethereal solution as much of the tuberculous fluid as will flow through the canula is drawn off. If large flocculent masses remain they should not be disturbed. The solution seems to possess a disintegrating effect on them and they will probably come away in the solution at the second tapping.

The method of procedure is as follows: "The parts are thoroughly scrubbed with German green soap and warm water and afterwards rinsed off with corrosive sublimate solution 1-2000. The aspirator has been previously prepared by allowing a stream of 1-2000 corrosive sublimate solution to run through it and also keeping it for a short time in the solution. The needle should be made aseptic by passing it through the flame of an alcohol lamp. The air is exhausted from the receiver and a medium-sized needle attached. This is plunged into the cavity and as much pus as possible drawn off. Frequently the pus is flocculent and will not run, and in such a case it is allowed to remain. Now as much of the saturated solution of iodoform in sulphuric ether as the cavity will hold is injected through the aspirating needle, from which the rest of the instrument has been detached. This must be done very slowly, as the ether boils at the temperature of the body, and on account of the expansion of the vapor some injury might be done if proper precautions were not taken. Another and smaller needle should be introduced near the first. This gives a vent and acts as a safety valve. As much ether should be allowed to escape as possible, and its escape may be aided by gentle pressure over the sac.

"Often the pus which could not be drawn out by suction is forced out by the ether vapor. The amount injected varies, generally from two to four ounces. When it has been done and the pressure relieved, the skin about the needles is cleansed, the needles rapidly withdrawn and the small orifices quickly sealed up with pieces of rubber adhesive plaster. If at any time the tension becomes too great, so that it causes much pain,

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\* Senn Tuberculosis of Bones and Joints, p. 258.

the small needle should be inserted and the accumulated vapor allowed to escape. The patient should always be etherized when injecting cold abscess cavities. The operation itself would be very painful without an anesthetic. After the operation the cavity becomes greatly distended, but after a few days the hardness begins to lessen, and gradually the tumor shrinks away.

"It is unnecessary to make an opening with the knife, in order to get rid of the flocculent pus when the ethereal solution is used.

"In one case in which this was done, and then the opening sewed up, it reopened in a few days at this point, and the progress of this case was much slower than with the others.

"Where the abscess has already pointed and broken, of course the aspirator is not used. The nozzle of the syringe is introduced directly into the sinus, and the fluid injected and retained as long as the patient is able to stand the tension—for in these cases, as a rule, an anesthetic is not necessary. After the injection a close antiseptic dressing is applied and allowed to remain in place as long as the discharge does not come through.

"In cases where there is a very deep cavity left after the spontaneous or artificial opening of an abscess, as in psoas abscesses, a medium-sized English webbing-catheter is introduced down deep into the cavity, and the injection made through that. Sometimes the catheter can be inserted to the depth of eight or ten inches, and the solution comes into contact with every portion of the abscess-wall. As a rule, the immediate result has been to diminish the amount of discharge, while, coincident with this, there is a general improvement of all the symptoms."

From experiments made on a number of cases at the Laura Franklin Hospital, the author is of the opinion that cases, where rupture has taken place and where there are sinuses leading to an old abscess cavity, do better under the daily injection of ten per cent. of iodoform in sterilized olive oil. Before the first injection the cavity and sinuses should be syringed out with a solution of peroxide of hydrogen, but it is not necessary afterwards. This treatment seems to induce healing more rapidly than the ethereal solution. Injections of bovine have also been tried but without good result.

In closing this chapter the following conclusions should be noted:

Simple "lancing" of a tubercular abscess, without antiseptic precautions and after-treatment, is useless, unscientific and dangerous.

Tapping and iodoformization should always be tried before more radical measures are attempted.

This procedure may be successful in cases where the diseased focus is inaccessible to the knife or curette.

If an operative measure is required let it be a thorough one—accomplishing a complete excision of the diseased portion.

Cases in which the abscesses have not opened are much more amenable to treatment than those which have sinuses leading down to them, although in many of the latter cases good results may be obtained.

The results which have been obtained are unquestionably good, and a large portion of cases of tuberculous bone and joint diseases in the third stage may be cured by the tapping and iodoformization.

## CHAPTER IV.

### SACRO-ILIAC DISEASE.

**Definition.**—Sacro-Iliac disease is an inflammatory disease of the sacro-iliac synchondrosis. It is rare and is usually found in young adults, although it occurs occasionally in children.

The acute form is very rapid in its course and is accompanied by high fever, suppuration and rapid exhaustion, from which the patient dies.

The chronic form is tuberculous, but, like most bone and joint diseases, may be excited by exposure or some local traumatism. Some cases are supposed to have been excited by rough riding, as in case of light artillery-men or young cavalrymen—or in women by difficult labor. Some cases are supposed to have been gonorrheal in origin.

**Symptoms.**—The symptoms in the early stages may be a feeling of indisposition, the patient is easily wearied, has abdominal distress, and difficulty in urination and evacuation.

As the disease progresses the pain is constant, but is increased in standing and relieved by lying down. When lying the patient rests on the well side. The pain varies

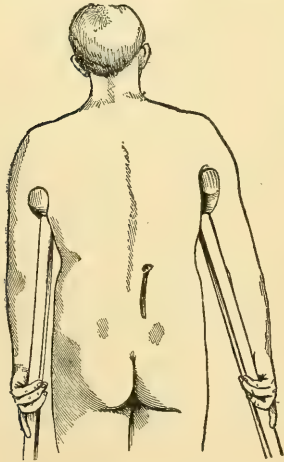


Fig. 262.

Line of incision for opening the lumbar abscess and operating on the sacro-iliac joint. (Van Hook.)

in situation and may be referred to the course of the sciatic nerve. There is sometimes a feeling as though the body were falling apart. It is sometimes burning in character. It is increased by pressing the wings of the ilia together. When the patient stands it is in a characteristic attitude, with the pelvis tilted so that the weight rests on the limb of the well side with the affected one hanging loose. The patient avoids jars, is cautious in his gait and walks on the ball of the foot; atrophy of the limb occurs early. A boggy swelling may appear over the joint, and if an abscess forms it may point in the groin, ischio-rectal fossa, sacro-sciatic notch, or open into the rectum, and pus and sequestra of bone be discharged.

**Diagnosis.**—From sciatica—by the relief on lying down.

From lumbago—by the tenderness over the joint, the pain is less diffuse and lower down. In lumbago the pain is greatly increased by motion of the trunk.

From psoitis (inflammation of psoas muscle)—by no increase of pain



Fig. 261.

Position characteristic of sacro-iliac disease. (Sayre.)



in extending the thigh—flexion increases the pain—while in psoitis there is no tenderness elicited by pressing the wings of the ilia together.

From hip disease—by the fact that in hip disease movement is limited in all directions; also there is no increase of pain by pressure on ilia.

From spinal caries—which lacks tenderness on pressure of wings of the ilia but has the prominence of the vertebral spine and rigidity of the spine.

**Prognosis.**—The prognosis is grave in any case. Recoveries occasionally occur, but most of the patients die from results of the prolonged suppuration, renal complications or secondary tuberculosis.

**Treatment.**—The patient should go about on crutches with a high shoe on the well foot. The pelvis should be fixed in a plaster of Paris bandage, or if confined to the bed extension should be made by means of weight and pulley on the well limb. Cauterization is advised over the joint and iodoform injections may be made, or injections of calcium phosphate as recommended by Kolischer.

If the abscess forms inside the ilium it may be necessary to cut down to the bone and chisel through it in order to evacuate the pus. The opening should then be packed with iodoform gauze.

## CHAPTER V.

### HIP-JOINT DISEASE.

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**Synonyms.**—*Morbus coxarius, morbus coxæ, coxalgia* and chronic osteitis of the hip.

**General Considerations.**—Hip-joint disease is a destructive tubercular inflammation involving the structures composing the hip joint. It most frequently originates in the head of the femur, but sometimes the acetabulum and occasionally the synovial membrane are the original sites of the disease. The most frequent predisposing cause of hip-joint disease is a tubercular diathesis. Most children who are affected with hip-joint disease have an hereditary tendency to diseases of this character. It is claimed by some authors that the disease is most frequently the result of an accident, but it can almost always be ascertained that children thus afflicted have a family history which points toward tuberculosis. Sometimes the parents of the child may be apparently healthy and yet the grandparents, or one of them, have died of tuberculosis. The disease seems to have a peculiar tendency to skip over one generation, so that the grandchildren of people dying from tubercular lung disease may be afflicted with diseases of the larger joints. This tendency may not of itself lead to an active disease, but as the result of a slight accident, as a fall on the hip or a severe strain, a small clot of blood may be formed which stops up some of the arterioles or capillaries nourishing that portion of the bone. This acts as a nucleus for an inflammatory deposit, and if tubercular bacteria are present in the system they are carried along by the blood current until they meet the obstruction. As a result of this stoppage their progress through the vessels is interrupted, the bacilli are caught in the mass of poorly nourished tissue, the conditions for the inflammatory change are present and a focus of tubercular disease is formed at this point which rapidly increases by the development.

The usual changes take place. At first to the naked-eye examination there is simply a reddened or hyperemic spot. Gradually this is increased in size, takes on a grayish hue with a surrounding hyperemic zone, and then the yellowish or cheesy breaking-down of the tuberculous mass. The development is more rapid if the function of the limb is kept up and the irritation of the inflamed portion is continued, and the result will be that there is a gradual disorganization of the bony tissue; the lime salts are dissolved out, and as a result the so-called "cold abscess" is formed, which contains the peculiar fluid and debris which constitute the contents of a tubercular abscess. There is after a time, a large accumulation of this fluid which penetrates to the joint cavity and distends the capsule, which it eventually ruptures, and a large abscess is formed in the surrounding tissues. This abscess has a tendency to seek the nearest or most accessible point of exit. Sometimes the point of exit will be on the surface near the joint; but when deep bands of fascia bar the way to the nearest surface the tendency

is for the tubercular pus to burrow along between the muscles until it reaches one or more points where exit is practicable. As a result of the destructive process the head of the bone may be partly or completely removed, and in some cases only a spur of bone projecting laterally from the shaft is all that remains of the neck, which has a bare and worm-eaten appearance. Changes may take place in the acetabulum also. On account of the strong traction of the muscles the head of the femur is made to press strongly against the upper rim of of the acetabulum. This gradually yields by absorption while the head of the femur slips up, leaving the lower portion. This gives rise to what is known as "migration of the acetabulum." In some cases the acetabulum becomes much deepened by new bony deposit in an attempt to cure



Fig. 263.  
Tuberculosis of head of femur.  
(Krause.)

by ankylosis, and this may be to such an extent that what remains of the head of the femur may be found deeply enclosed in the bony tissue of the acetabulum. Sometimes both hips are affected simultaneously, or one may recover and the other become affected later on. The "migration of the acetabulum" is accompanied by shortening of the limb, which may be drawn up so far as to bring the great trochanter above Nelaton's line. Sometimes the acetabulum is perforated, but usually a thick wall of newly formed fibrous tissue shuts off the abscess from the pelvic cavity. The acetabulum is usually filled with soft, velvety granulation-tissue. Cure takes place by absorption or calcification of the the tuberculous tissue, or by discharge externally, with the result of throwing off the diseased portion and, later, the formation of bony tissue and ankylosis.

**History and Symptoms.**—When a child is affected with disease of the hip-joint it may be traceable to some accident as an exciting cause, but not always, as children are always falling and hurting themselves and meeting with slight accidents of which they can give no account. But there is usually the predisposition to tubercular disease as already mentioned. The accident may consist simply of a fall on the hip, a sudden strain or wrench, or perhaps the exciting cause may be a severe cold. The child has a slight tendency to stiffness in the morning. The first thing noticed is a condition of malaise. There may be no complaint of any special pain, but if the child is carefully watched, a slight limp may be detected, and when the child stands it will be noticed that he rests on one foot, allowing the other limb to remain flexed, or slightly abducted, and he favors the affected side in whatever he is doing. These symptoms may grow less apparent or disappear later in the day. If the parents are particularly observant these slight symptoms may lead them to consult a physician,



Fig. 264.  
Position assumed in standing with slight abduction of right leg.  
(Bradford & Lovett.)



and often at this early stage there are conditions which lead to diagnosis of hip-joint disease. As the disease progresses the child may have pain at night, with the peculiar cry which is known as the "nocturnal cry" or the "osteitic cry." After the child falls asleep he suddenly awakens with a scream or groan, but by the time the nurse reaches him drops off again, and this may happen a number of times in the early portion of the night before the child sleeps for any length of time continuously. In many cases this symptom is so prominent that the child gets very little or only disturbed sleep. The location of the pain varies, but it is generally referred to the knee-joint or the anterior and inner side of the thigh. Its cause is not clearly understood, but the intimate relation of the sciatic, obturator and anterior crural nerves seems best to explain the reflex pain. All these symptoms gradually increase in severity, the limitation of motion is more marked, the child refuses to play about; or, if at all, it will be in some position in which he does not have to move, and he will not use the affected limb any more than he can possibly avoid. He tries to make extension by pressure on the affected foot by the well one. An apparent shortening of the limb becomes noticeable, which is due to the tilting of the pelvis upward on the affected side. The hip itself changes in shape, becoming broader, rounder and larger than that of the opposite side, and is accompanied by a shortening or loss of the gluteal fold. This goes on until the formation of an abscess. The presence of the abscess and its final opening and evacuation may affect the general health to such a degree that the child dies of exhaustion or from amyloid disease of the kidneys, or secondary tuberculosis.

Particular attention should be given to the motions of the hip-joint in the early stages of the disease. In the early stage the position of the foot may be normal as regards eversion or inversion, but this depends largely on whether the case has been treated or not. If the child has had no treatment there may be eversion in the early stage, but after the formation and discharge of abscess the foot is turned in and often rests on the other foot. The most severe pain is usually experienced during the so-called second stage, before the rupture of the capsule from the accumulation of fluid in the joint and increased tension, but after the rupture of the capsule the tension is lessened and the pain is less severe. As the disease progresses the limb becomes more and more fixed, and after the rupture of the capsule the limb is adducted and the foot may be rotated inward. The atrophy of the muscles of the thigh begins in the early stages; there may be rise of temperature before rupture of the abscess, but this is uncertain.

**Examination.**—Where a child has a history corresponding to the symptoms which have been detailed, a careful examination should be made of the entire body. He should be stripped and placed with his

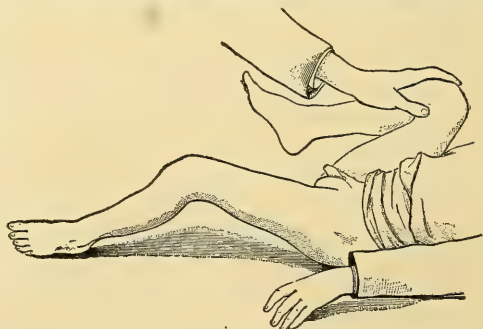


Fig. 265.  
Estimation of disease by flexion. (Bradford and Lovett.)

back to a strong light, and, standing on a level surface, it will be noticed that he stands with his weight on one foot and the leg of the affected side slightly flexed, abducted and rotated outward: the gluteal fold is much shorter than on the other side, and the buttock flattened and

broadener. If the child is then placed on his back on a hard surface and an attempt is made to press the leg down so that the popliteal space touches the table the spine will become arched as the leg is pressed down, or if the thigh is flexed on the abdomen the spine is pressed down flat on the table. Attempt should be

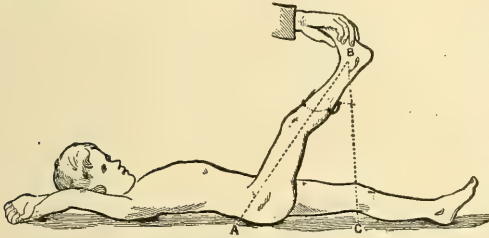


Fig. 266.

Estimation of flexion. (Bradford and Lovett.)

made to move the limb in every direction, and the most distinctive sign characteristic of hip-joint disease is the limitation of motion in every direction; neither flexion, extension, abduction, adduction or rotation can be carried to the fullest extent. The muscles about the joint are all affected by spastic contraction, and thus motion is limited. In some cases it may be necessary to diagnose between inflammation of the hip joint and inflammation of the lower lumbar vertebræ; both of these joints are acted upon by the ilio-psoas muscle, and any disease which affects either will affect the muscle, causing spastic contraction. The result will be that the thigh is flexed upon the abdomen and it is impos-

sible to fully extend the limb on account of this spastic contraction. However, this being the only muscle which is affected by both disease of the spine and hip, when the spine is inflamed it limits the motion of the hip-joint only in complete extension, outward rotation and abduction; the motions of rotation inward, adduction and flexion are unaffected; whereas in hip-joint disease, where all the muscles about the joint are contracted, the limitation of motion is the same in all directions.



Fig. 267.

Position of the abducted limb when the pelvis is brought straight. (Bryant).

Also the flexibility of the spine may be ascertained by the method detailed in the chapter on Pott's disease.

Another important symptom is the atrophy of the muscles of the thigh. Comparative measurements of the two limbs will always show a diminution in the size of the affected side, and in the very early stages it often varies from one-half to three-quarters of an inch or more, and sometimes is so marked that it can be easily seen. Apparent shortening of the limb is easily determined by comparative measurements from each anterior superior spinous process of the ilium to the malleoli of the corresponding limb. Tilting of the pelvis is determined by stretching one line between the two anterior superior iliac



Fig. 268.

Position of patient when standing, with disease of the right hip-joint and an abducted limb. The pelvis is tilted up on the affected side, and the limb thereby apparently shortened.

spines, and another from the pubis to the umbilicus. In a normal case these lines should cross at right angles, but where the pelvis is tilted the angles are not right angles. In the latter stages, on examination, the

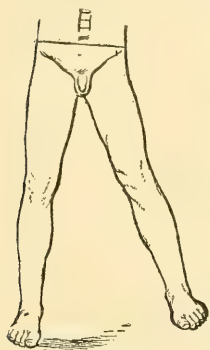


Fig. 269.

Abducted position of diseased left limb; pelvis brought into natural position at right angles to spine. (Bryant.)

symptoms are much more apparent, and the presence of abscesses, the greater limitation of motion, the shrinkage of the limb, the position of the leg with rotation inward and possibly actual shortening of the limb as demonstrated by measurements, all go to make up the diagnosis. It is believed that the most important symptom of all, however, is the presence of spastic contraction of the muscles. An abscess apparently coming from hip-joint disease but without limitation of motion would not indicate disease of the joint. Occasionally abscesses from a diseased spine may burrow along the fasciæ and point at exactly the usual site of abscesses resulting from hip-joint disease. In such cases the symptom mainly to be relied upon and which is of the most value, is the presence or absence of limitation of motion. To determine whether there is actually shortening of the limb, or whether the displacement has taken place from the loss of the head of the femur, it is well to make an

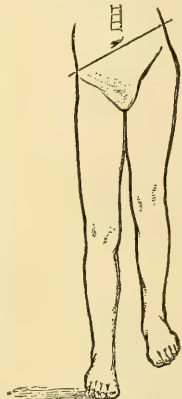
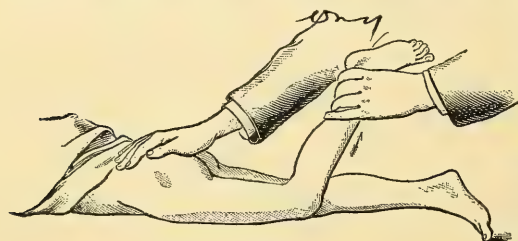


Fig. 270.

Apparent elongation of the right lower extremity in hip disease on the left side due to abduction of limb and necessary tilting upward of the pelvis on the sound side to allow of abducted limb being brought into line with the body. (Bryant.)



271.

Examination for Psoas Contraction or Limitation of Extension in Hip Disease.—Hoffa.

femur has been absorbed, so that there is displacement, the trochanter will be at some distance above the line.

**Prognosis.**—The prognosis in the case of hip-joint disease is always more or less doubtful. The family history must be taken into consideration, the general condition of the child, the stage at which treatment is begun and all the attendant circumstances. Many cases recover spontaneously with deformity which is permanent; other cases, in spite of the most careful treatment, go on to a fatal issue. As a rule under treatment, if begun early, the prognosis may be considered generally favorable to life. Many cases recover completely; some may have only slight atrophy and stiffness of the limb, others have partial ankylosis with slight deformity, and others complete synostosis with deformity in bad position, but these last are the ones in which there has been no treatment



or where it has been begun late in the course of the disease. With proper treatment the deformity ought not to be great.

**Treatment.**—If a case in which hip-joint disease is suspected is brought to the surgeon no delay should be allowed before commencing the treatment, even though it may seem advisable to treat the child by purely mechanical measures. The patient should immediately, during the process of construction of the brace, be placed in such a position as to relieve the joint from all functional activity. This is best accomplished by placing the child in bed, the use of the extension being applied in such manner that in whatever position he may be, whether lying on one side or the other, the extension is constant and always in line with the original deformity. This is accomplished by the application of adhesive straps to the limb and a piece of board four or five inches in length, which goes across the sole of the foot without touching it; to this the pieces of adhesive plaster are attached, so that they do not touch the malleoli and cause irritation, a hole being bored through the middle of the traverse and the end of a rope put through and knotted. This rope runs over a pulley attached to the foot of the bed, and to the outer end of the rope is fastened a weight, varying according to the size of the child, from seven to fifteen pounds. If the disease persists and it is found that marked improvement does not take place in three or four weeks it is generally inadvisable to keep the patient for a longer period confined to the bed, on account of the lack of exercise and the consequent impairment of the health when it is kept up for a prolonged period.

As soon as it is ascertained definitely that a child has hip joint disease it is better to apply some form of apparatus which will carry out the indications for treatment and at the same time allow him to take exercise. It is doubtful if any form of external application is of much use. The joint is so far from the surface that even the old school authorities consider it of very little use to apply lotions or

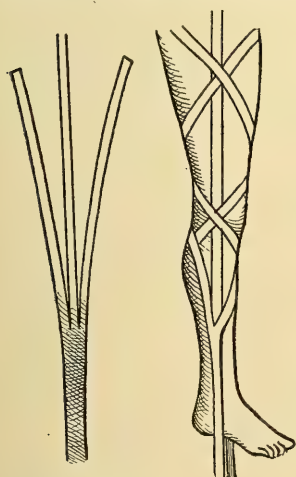


Fig. 273.  
Adhesive Straps Applied for Extension.

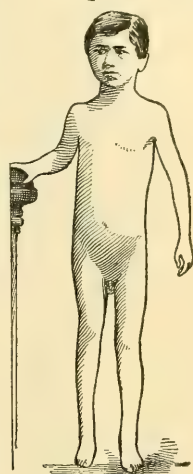


Fig. 272.  
Deformity After Coxitis.



Fig. 274.  
Long Hip Splint.

plasters or any form of counter-irritant; still it is believed that the use of daily applications of compound iodine ointment has been of benefit in incipient cases. In some cases, when it may be inadvisable to apply walking apparatus, the plaster of Paris bed of Phelps, or Bradford and Lovett's bed frame, or the very excellent one of Gorham, of Albany,

may be used. By the use of these portable beds the patient may be moved about from place to place without disturbing the extension.

The treatment which allows of exercise and maintains extension at the same time is accomplished by the use of certain forms of splints or braces, which are mostly based upon the general plan of the original Davis splint.

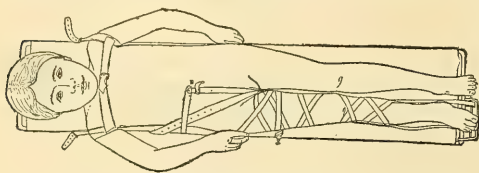


Fig. 275.

Bed Frame with Traction Apparatus Added.—  
(Bradford and Lovett.)

of steel extends along the limb to the foot. This may be arranged with a device by which it can be lengthened or shortened at the pleasure of the wearer. From the pelvic band two padded bands pass just between the limbs under the perineum, so that the patient sits, as it were, in a saddle formed by the two perineal bands.

The long steel bar which runs from the pelvic band to the foot is supplemented by a short piece which runs at right angles underneath the sole of the foot, and is padded with rubber or leather. In order to make the extension

strips of adhesive plaster are applied to the limb, and to the lower end of the strips buckles are fastened. These buckles are attached to the strips of webbing which come up from the foot-piece. The extension is made by drawing downward on the adhesive straps and upward by the perineal bands. The result is that if these are drawn tightly the pressure of the femur on the acetabulum is relieved. To say that the head of the bone is actually drawn from the socket is incorrect, because the muscles about the thigh and hip are so large and strong that it would be impossible with the means in hand to separate the head of the bone from the acetabulum; it is only in theory that this takes place, but there is no doubt that the traction which is made by means of the brace has a tendency to relieve the spastic contraction of the muscles about the joint, and thus lessen the irritation caused by the friction of the apposed joint surfaces. At the same time the brace acts as a perineal crutch and no weight is borne on the affected limb. The brace must be sufficiently long so that the cross-piece which passes under the foot does not touch the sole. There should be a space of at least one inch between the sole of the foot and the top of the cross-piece.



Fig. 276.

Phelps' Plaster-of-Paris Portable Bed for Hip-Joint Disease.

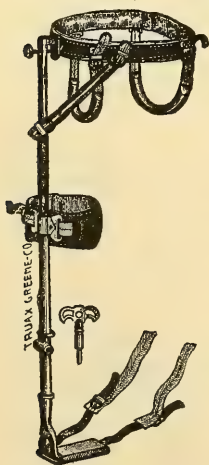


Fig. 277.

Taylor's Hip Splint  
with Abduction  
Screw.

There are many modifications of the brace described. In the author's brace there is adopted, instead of the ordinary cross-piece for the foot, an



arrangement which consists of two crutch ferules with rubber tips, one on each side of the foot and connected by a horse-shoe-shaped piece of steel which passes behind the foot. The attachment to the plaster is made of elastic instead of leather, and the result of this modification is that the child can walk with his foot much nearer the ground, as there is no foot-piece to tread upon, while the constant traction of the elastic strap keeps up the extension, whether the child is walking or not. In the ordinary braces as manufactured the steel extension bar and the pelvic band are fastened directly together. The result is that the joint in the brace is not over the hip-joint, and on account of the irritation caused by the presence of the pelvic band at a point so low down it is almost always worn at a point two or three inches above where it was originally intended, with the result that the child is unable to sit down with any ease, and the limitation in motion is very marked. To obviate this the author has had constructed a brace which has the combined points of the Taylor and the Phelps brace. Instead of a single perineal band only a narrow round steel rod passes around the pelvis. The object of this is to make as little pressure as possible upon the prominences. Two other broader, padded steel bands pass around the trunk higher up, to the lower of which the straps are attached. This is placed intentionally two or three inches above the joint around the waist, and another band still higher goes about the middle of the chest; these are all riveted to a perpendicular steel bar which passes down and terminates in a spur which extends to a point exactly opposite the hip-joint. To this spur the long side bar is attached and is so arranged with a heavy nut that the joint may work freely or be set at any angle.

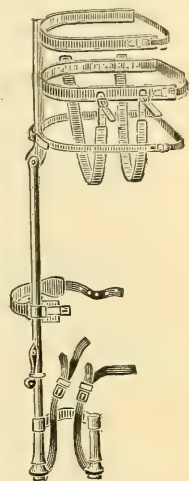


Fig. 278.  
Wilcox's Hip  
Splint.



Fig. 279.  
Thomas' Splint Applied.

This brings the joint in the brace where it should be, i. e., exactly opposite the hip-joint, and thus obviates the interference with motion which occurs in the ordinary braces. The child is able to sit up on a level surface or even to bend forward without difficulty, while extension may be kept up to any degree. If desired, by simply tightening the nut at the joint, motion is absolutely prohibited, and all the benefit derived from the Phelps brace may be obtained. In applying it the perineal straps should always pass underneath the lower or pelvic band. The foot-piece which has been described makes it much easier for the child to walk than where the cross-piece is employed, and the elastic traction straps are preferable to the leather webbing straps, because the traction is constant whether the child is walking or not. In all the braces which are made on the principle of the long-walking splint the extension may be increased or diminished by lengthening the long steel bar. This may be done by means of a key and ratchet or by an endless screw, or any of the various other ingenious devices



which aim at the same end. In severe cases of adduction of the limb which occurs in the third stage Shaffer has used what is known as an abduction screw, which is a screw passing through the upper portion of the long bar and impinging on a plate fastened to the pelvic band. As this screw is turned down slowly and a little at a time it has the effect of throwing out the lower portion of the brace and relieving the extreme adduction. Some form or modification of the long splint is most frequently used in this country, and for all-round purposes it is probably the best.

In England, the Thomas splint which gives absolute fixation without extension is popular. It is believed better results can be obtained when the

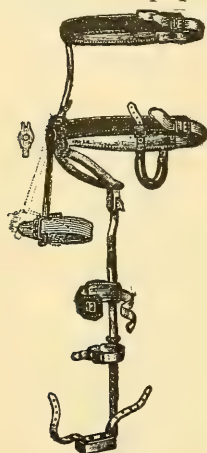


Fig. 280.  
Phelps' Brace for  
Single and Double  
Hip-joint Disease.

brace is left on at night; but sometimes, on account of the delicate skin of the patient and the child's intolerance of apparatus it is necessary to give relief at night, and for that reason the brace is removed and extension with the weight and pulley employed. But the utmost care should be exercised that the patient should never at any time during the treatment be allowed to bear his weight on the diseased limb. Phelps, of New York, treats the cases by absolute fixation in the joint, his apparatus extending from the axilla to below the foot so that the limb is kept in a state of extension without any motion whatever. He claims better results from this method of treatment because by this

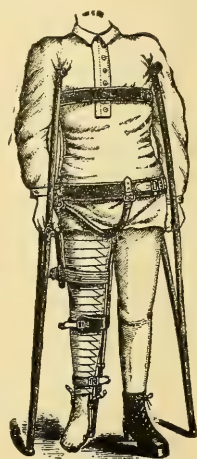


Fig. 281.  
Phelps' Brace  
Applied.

means the functional hyperemia of the joint is avoided, and he also claims that a very small percentage of cases of ankylosis follows this treatment. It is, however, exceedingly awkward and difficult for a child to get about with an apparatus of this sort. He is perfectly rigid from the shoulders down, and sitting can only be done on one hip, and the child is in a very awkward and strained position. He is obliged to walk about with crutches and a high shoe on the opposite foot, and retains the brace both night and day; it is doubtful whether the results obtained by this brace are any better than those by the ordinary brace which allows motion. In cases which cannot walk about Phelps uses a similar form of apparatus, but with a pulley which is placed over the side of the bed and straps which go around the upper part of the thigh in such a manner that when a weight is attached the extension is made laterally, with the intent to diminish the lateral pressure of the head of the femur in the socket.

The late Hutchinson, of Brooklyn, thought that sufficient traction could be made by the weight of the one limb alone. He estimated that the weight of the limb was equal to one-sixth of the entire body, and believing this to be sufficient for extension he thought that all that was necessary to do in treatment of hip joint disease was to allow the limb to hang suspended. For this reason he had a high shoe placed on the well foot, raising the patient about four inches or more from the ground, and

allowing him to walk about on crutches. The affected limb simply hung loose and dangling. Some good results are reported by the author of this method, but it has not become popular. The author has attempted to use additional weight by placing a lead sole on the shoe so as to give still more extension, but the result has not been satisfactory; the patient does not do as well as by either complete or partial fixation of the joint with extension. Various other devices, such as Stillman's sector splint, Sayre's or Robert's short braces, and a number of others have proved less satisfactory than the long brace.

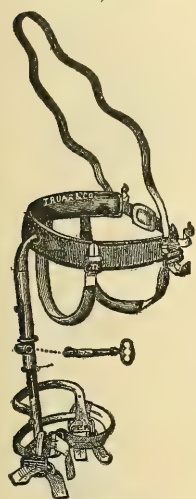


Fig. 282.  
Sayre's Short Splint

The difficulty with all forms of braces which are applied to the limb by means of adhesive straps, or where continuous pressure is made for a long time with bands, as is the case with the perineal band, is that the skin becomes chafed and sore, and the child, especially in the summer, experiences great discomfort. Gorham, of Albany, thinks that by crossing the perineal bands so that the pressure does not come so much on the perineum as on the tuber ischii much discomfort is avoided. In cases of chafing from perineal bands it is necessary frequently to let up the pressure for a while until the skin gets toughened, and the application of some form of astringent may be demanded.

For this purpose a solution of powdered tannin in hot water applied at night has been found to be as good as anything; some-

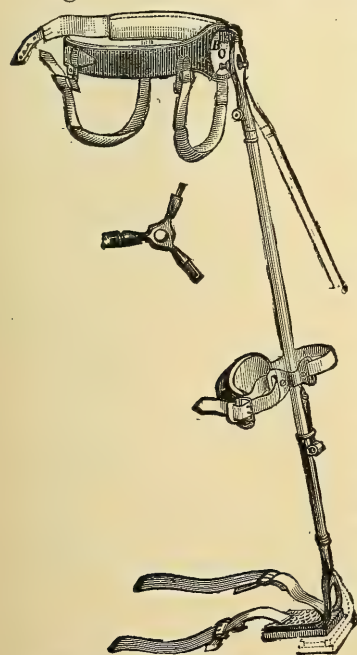


Fig. 283. Sayre's Long Splint.

times alum does very well, but all oily or greasy preparations should be avoided. If the patient lives in the country where the white-oak tree abounds the inner bark of the tree may be removed and steeped in water until an infusion is obtained, which can be applied to the skin. This preparation is used in the country to apply to the necks of horses when they become galled by the collar in hot weather. Where the skin becomes sore underneath adhesive straps the only thing to do is to remove them and to re-apply the straps in some place where the skin is sound. In cases

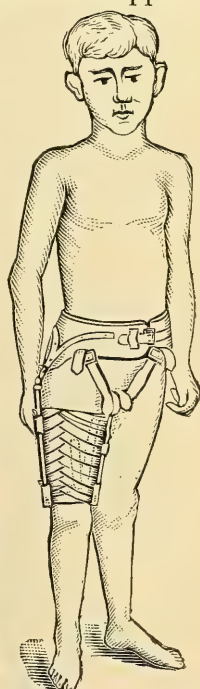


Fig. 284. Robert's Short Brace Applied.

where the calf of the leg is well developed an accurate cast may be taken and over this may be moulded a leather or felt legging, to which extension straps may be applied, the bulge of the calf giving sufficient resistance to keep the



leggin in place. Care must be taken that the straps do not draw the leggin down on the ankle and cause ulceration of the skin over the bone. When the disease is far advanced and abscesses have formed the condition is more serious and the question of operative measures becomes an important one. There has been much discussion among orthopedists as to when it is better to operate on these advanced cases. Surgeons who believe most firmly in mechanical measures are, as a rule, opposed to the use of the knife and the excision of the joint; and in many cases it is possible to avoid not only the operation of excision of the joint but even the free opening of the abscess cavity. The discussion of the treatment of tubercular abscesses is given in another chapter, so that the details need not be given here. But the author reiterates his belief as to the injurious effects of the opening of cold abscesses and protests against it, believing that by aspiration and injection of ethereal solution of iodoform many cases may be cured within a short time, without the bad effects which follow the evacuation of the tubercular fluid.

**Operative Measures.**—These consist of aspiration of the capsule to relieve pressure, trephining through the trochanter, or ignipuncture to remove the diseased foci, or erosion or excision of the joint. Where a case has progressed so far that it becomes probable that no other method will bring relief excision should be resorted to. The disease should not be allowed to progress to the extreme, but only so far as to indicate that it cannot be treated successfully by the more conservative measures which have been attempted to arrest its progress, and that the ultimate result, if allowed to go on, will be either complete destruction of the joint or death of the patient. As soon as this is determined the operative measure should be carried out. Indeed, by some surgeons it has been considered important that the operation should be performed at a very early stage of the disease, long before abscess has been formed, the idea being that at that time it is easy to cut down and remove absolutely the diseased focus and thereby obtain healing by first intention and so reduce the duration of the disease to a very short period.

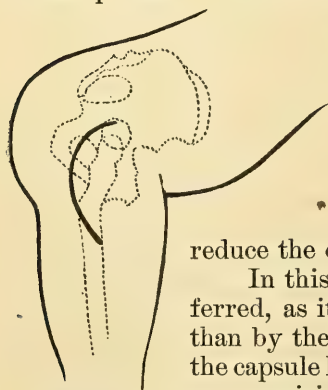


Fig. 286.  
Posterior Incision.

In this early operation the anterior incision is preferred, as it is much easier to get at the head of the bone than by the posterior (Fig. 286) or lateral incision. After the capsule has been opened and the head of the bone exposed any suspicious portions of the bone are carefully scraped out by means of the flushing gouge, which allows a stream of antiseptic solution to play constantly upon the surface of the wound while the gouge is being used. Then the leg is placed in the proper position and the wound allowed to heal. When, however, the disease has progressed to the stage of abscess and an operation becomes imperative the lateral or posterior operation is better, and it is believed

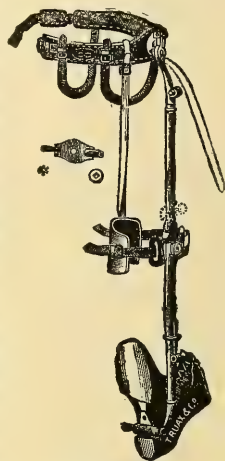


Fig. 285.  
Sayre's Long Splint  
with Shoe.



that better results may be obtained by the lateral or Langenbeck incision. (Fig. 287). The reason for preferring this is that the fibres of the gluteus muscle instead of being cut transversely are merely separated, the incision being made in the long axis of the muscle, and it also gives a better opportunity for removing portions of the shaft of the bone if they are diseased than does the posterior incision. On the other hand, where only

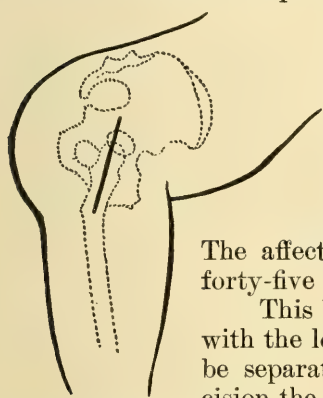


Fig. 287.  
Lateral Incision.

the head of the bone is diseased it is much easier to remove it by the posterior incision than by the lateral, although the fibres of the muscles are cut transversely in making the operation. Preparatory to the operation all aseptic measures should be carried out, and after the anesthesia is complete the patient be placed on a table, lying on the well side.

The affected limb should be flexed to an angle of about forty-five degrees with the body.

This brings the fibres of the muscle directly in line with the longitudinal axis of the bone and allows them to be separated instead of cut across. For the lateral incision the knife is introduced about an inch above the great trochanter and is passed directly down into the joint and as far along the shaft of the bone as may be deemed necessary. As a rule it is not necessary to ligate any vessels, although at first there may be sharp hemorrhage from some small vessels. These can be controlled by means of forcipressure applied for a short time. The flaps should be retracted and the incision continued down through capsule and periosteum and the muscular attachments to the trochanters dissected off. If the bone is diseased under these muscular attachments the fibrous tissue may be easily stripped off with the periosteal elevator. If the underlying bone is healthy the removal of the muscular attachments is much more difficult and they should be cut away with the knife, using great care to keep as close to the bone as possible. After the bone has been denuded and the joint has become accessible the head of the bone or what remains of it can be turned out. All diseased portions should be removed, even though a considerable portion of the shaft must be taken. In some of the author's cases at least five inches of the upper end of the femur has been removed. Occasionally the bony tissue may appear to be healthy while the medullary cavity contains gelatinous, unhealthy material. This should be scraped out by means of a long narrow curette, and excellent results are obtained by cleansing out this cavity carefully and filling it with iodoform. If the bones of the acetabulum are diseased they should be thoroughly curetted, as well as all the granulation tissue about the abscess cavity and the sinuses, and every vestige of diseased tissue should be removed. This is important, because if it is not done re-infection and a further continuance of the disease is likely to occur. The operation may be performed quickly. Vessels of any size that have been cut and which continue to bleed may be tied with cat-gut, or oozing of any extent may be stopped by the use of a douche of hot water which contains the tincture of iodine in solution. This iodinated water should be of a dark straw color, and should be as hot as can be used without affecting the tissues; it is a very rapid and effectual hemostatic. The

wound should only be brought together sufficiently so that there will be no gap, and one or more large drainage tubes placed down deep into the joint.

Three or four deep sutures and perhaps a few superficial sutures may be required to close the wound. Attempts at closing large wounds of this sort with the expectation of healing by first intention are apt to be followed by failure, because it is very difficult to be sure that every vestige of the diseased tissue has been removed, and it is believed that the treatment described above is preferable. Sometimes it is better to pack



Fig. 288.  
Sayre's Wire  
Cuirass.

with iodoform gauze than to use drainage tubes. For the after treatment the patient may be placed in the wire cuirass of Sayre with extension of the limb (Fig. 288), or he may be placed in bed with the ordinary form of extension and sand bags placed at either side of the limb so that the leg is held in a straight position. It is believed that the use of the cuirass is attended with better results than is the other form of treatment because when once in this apparatus the limb is kept immobilized and the patient can be moved about from one place to another, if desired. The dressing should not be changed sooner than is necessary; the drainage tubes should be left in only so long as required for the active discharge from the wound; the suture may be removed at any time from ten days to two weeks after the operation, and as soon as healing has taken place passive motion to the joint should be made. Extension should be kept up so as to avoid any unnecessary shortening of the limb, though, of course, shortening, where any great amount of bone has been removed, is unavoidable. Sometimes the wounds are a long time in healing, occasionally extending over a period of a year or more. This is probably occasioned by the facts that slight spiculæ of diseased bone still remain and that it is necessary that these should be cast off before complete union can take place. However, it is the general result that immediately after the operation a patient begins to improve in health. Sometimes even in the most desperate cases where it seems impossible that they can bear the shock of an operation the relief experienced is immediate. In many cases where the temperature has been running from 102 to 103 every day, with signs of hectic and general consumptive tendency, the temperature drops at once to normal and remains there, showing that an immense relief from sepsis has been given to the system; and although the patient may be long in obtaining absolute healing of the wound he will begin to show improvement from the first. The amount of shortening in different cases after operation varies.

In many cases there is shortening to the entire amount of bone that has been removed; in others there is a reproduction of bony tissues so that the shortening is very much less than would be expected. The limitation of motion is also variable. In one or two cases which were most unpromising before the operation the motion after the operation was perfect in every direction, although there was shortening of the limb.

In cases of ankylosis following hip-joint disease, where the ankylosis has taken place in an unfavorable position, the only remedy is osteotomy. Osteotomy may be performed by the chisel and the limb brought into the

straight position. This is safer and better than the attempt to relieve the ankylosis by fracture. In all cases of hip-joint disease, whether treatment has been by means of the brace or by operation, the child should be carefully watched for several years, because there is always a tendency for the disease to return unless great care is taken, and the splints should never be removed until it is certain that the recovery has been complete. In cases where there has been shrinkage of the limb with a lack of development of the muscles much may be done by the use of electricity, baths and massage. These should be kept up until the nutrition of the limb is thoroughly restored and the strength is equal to that of the other side. Where there is actual shortening it is best to equalize the length of the limbs by the use of a high shoe on the affected side. In this way the tendency to static curvature of the spine is avoided and the patient walks with very much greater ease than if it were not applied.



## CHAPTER VI.

### CONGENITAL DISLOCATION OF THE HIP.

**Definition.**—Not infrequently a child is born with one or both hips dislocated. This dislocation differs from the ordinary dislocation in the fact that there is no rupture of the capsule, and also that the head of the femur escapes easily from the acetabulum on account of the abnormal shallowness of the socket.

**Etiology.**—Four theories are given to account for this condition. The causes mentioned are heredity, mechanical intra-uterine pressure, or traumatism, pre-natal disease, and arrest or defect of development.

Examples of the frequency of cases in one family are cited to establish the theory of heredity. The theory of mechanical intra-uterine pressure, or traumatism from diminished quantity of liquor amnii, or from a blow or fall on the mother's abdomen, do not appear to have sufficient proof to sustain them. The theory of pre-natal disease has many supporters, and it is supposed that some pre-natal nervous condition affects the muscles, causing abnormal contraction and dislo-

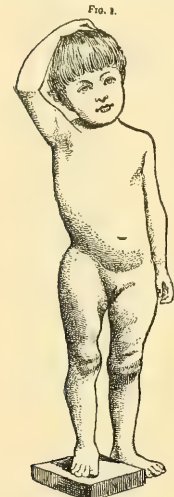


Fig. 289.  
Congenital Dislocation of Right Hip—Phelps.



Fig. 290.  
Congenital Dislocation, Rear View—Phelps.

cation. The fourth theory is now the most widely accepted and is supported by the fact that the acetabulum is not sufficiently developed to hold the head of the bone in place.

The most frequent congenital dislocation is seen when the head of the femur lies upward and backward on the dorsum of the ilium; but sometimes the displacement takes place toward the pubis, or into the obturator foramen or downward and backward.

All the parts composing the joint ordinarily are present except the ligamentum teres, which may be lacking, but the acetabulum is shallower, flatter and proportionally smaller than usual, and may be triangular. It may be filled with fat and connective tissue in infants, but in adults it may be filled with exostoses. Depressions may exist on other portions of the pelvic bones where the head of the femur has rested. The head of the bone is smaller than normal, but proportionally larger than

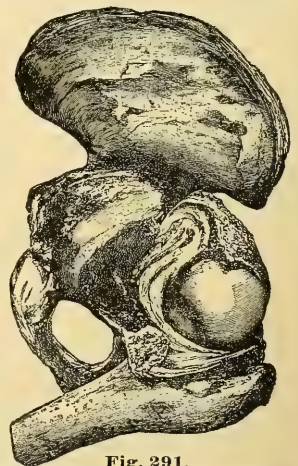


Fig. 291.  
Dislocation Upward and Forward—Phelps.

the acetabulum. The neck of the bone may be short or wanting. The ligamentum teres is long and thin or sometimes wanting. The capsule of the joint is enlarged, thickened and relaxed, and the body is suspended on the elongated capsule as shown by Volkman, like the old-fashioned stage-coach on leather springs. The pelvis may change in shape but not sufficiently in the female to interfere with parturition. The gluteal muscles become atrophied.



Fig. 292. Double Congenital Luxation Before Operation—Hoffa.

**Symptoms.**—The most prominent symptoms are the extreme lordosis and the peculiar “goose gait.” The lordosis varies according to the amount of displacement and is due to the effort of the child to preserve its equilibrium. The gait is waddling or lurching. There may be no pain, but the patient tires easily in walking. As the child grows older, however, there may be a great deal of pain and the patient become practically disabled from walking. The condition may not be noticed until the child begins to walk, and the displacement of the trochanters, especially in cases of double dislocation, may not be discovered until late. The children are especially subject to sprains and wrenches.

The chief diagnostic points are the position of the trochanter above Nelaton’s line and the possibility of its being drawn down to its proper position by gentle traction. The extra breadth of the perineum, the extreme lordosis, the abnormal mobility of the joint and the waddling gait are also important diagnostic points.



Fig. 293. Double Congenital Luxation of Hip, After Operation. Side view—Hoffa.

**Treatment.**—Of the treatment Bradford and Lovett (1) write: “When one considers the problem to be solved in the treatment of congenital dislocation of the hip it is easy to see why the remedial means proposed are in general so inefficient; an imperfect acetabulum, perhaps almost wanting, a flattened and deformed head of the femur, and strong muscles and body-weight antagonizing every therapeutic measure.”

Continuous extension over a period of two years or more has been the method mostly employed, and a number of cases of alleged cures by this method have been reported, but some have been discredited. Brown, of Boston, was the first to achieve success by this method in a case of a patient four years of age with congenital dislocation of both hips. The child was kept in bed for thirteen months and constant traction made by weights and pulleys. Then the wheel crutch was employed, without allowing her to rest her weight on the floor, and the cure was complete at the end of three months. Bradford, of Boston, has also been successful in the treatment of this condition by means of continuous extension.

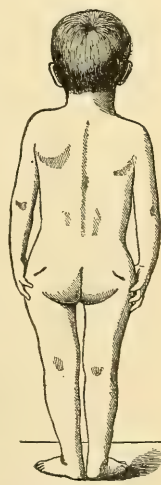


Fig. 294. Double Congenital Luxation of Hip, After Operation. Back View—Hoffa.

Various kinds of apparatus have been tried to maintain the head of the femur in position and these have consisted of some form of jacket or brace which encircled the lower portion of the body and extended well down over the hip. All of the mechanical measures for the treat-

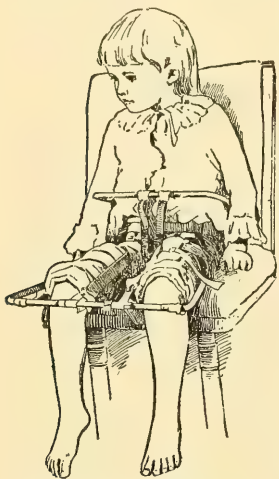


Fig. 295. Traction Appliance for Congenital Dislocation.—(Bradford.)

ment of this dislocation are admitted by orthopedists to be largely unsatisfactory in their results. Within the past few years operations have been performed with some degree of success. In Vol. VII, 1894, of the Transactions of the American Orthopedic Association are found exhaustive articles and discussion of the subject. Hoffa, of Wurtzburg, Lorenz, of Vienna, and Bradford, of Boston, are the men who have accomplished the most in this line. The operations vary somewhat. Hoffa, using the Langenbeck incision, cuts down and frees the trochanter from the soft parts and muscular attachments, and then scoops out the acetabulum with a curette in order to deepen it. The dislocation is reduced, a flap is turned up from the bottom of the acetabulum to surround the head of the femur, and the limb is held in position by a plaster of Paris splint.

Lorenz's operation differs by having an anterior incision down to the joint. The acetabulum is hollowed out and the reduction of the dislocation effected, and the limbs placed in slight abduction in plaster of Paris splints.

Bradford's operation is much like that of Lorenz, but he finds by careful dissections that the chief obstacle to reduction is the tension of the ilio-femoral or "Y ligament of Bigelow." Therefore he makes his incision somewhat more laterally than that of Lorenz, and adds a cross incision for the purpose of releasing the tension of the above-mentioned ligament. Bradford is conservative in the estimate of the results of his operations. Hoffa and Lorenz are more enthusiastic, the latter claiming that up to August, 1894, he had "operated upon ninety-nine cases of congenital dislocation of the hip joint without a single failure"—a most extraordinary record.

One other method which may be mentioned is that of Lannelongue, which consists in producing a deposit of bony tissue about the head of the femur by injecting a ten per cent. solution of chloride of zinc about the joint. There is hardly enough data as yet to form an opinion as to the utility of this method of treatment.

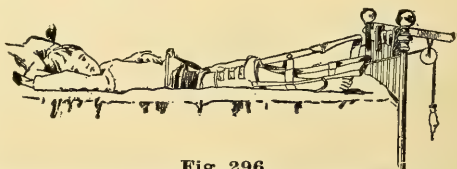


Fig. 296. Weight-and-Pulley Traction—Congenital Dislocation.—(Bradford.)



## CHAPTER VII.

### KNEE-JOINT DISEASE.

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**Knee-Joint Disease.**—**SYNONYMS.** Strumous arthritis, or white swelling; German, *scrofulose gelenkentzündung*. French, *tuberculose articulaire*. Latin, *tumor albus*.

**Etiology.**—Knee-joint disease may occur at any age, but it is most frequent in young children or in young adults. It may originate either in the bone, the synovial membrane, or in the articular cartilages. In youth it originates about equally in the synovial membrane or in the bone, but in the adult more frequently in the synovial membrane. The cases in which the disease begins in the articular cartilages are rare, but they occur occasionally. The general causes are much the same as in hip-joint diseases, but a larger proportion of cases originate in the synovial membrane on account of the greater surface which is more exposed to injury. The pathological conditions are similar to those of hip-joint disease, which need not be noted at length again.

**Symptoms.**—The ordinary division into three stages prevails. In the first stage, in which the disease is slow in its onset, the symptoms may be of an indefinite character; the patient may show no particular signs of constitutional illness, but frequently there is a condition of malaise, the patient seeming to be in low tone and slightly out of health. There are symptoms of stiffness and lameness, the stiffness being especially apparent in the morning but perhaps passing off later. There may be a slight limp which comes from the pain or inflammation caused by motion. This may pass off after the patient has slept and rested for a few hours, but becomes more apparent later in the day. The pain is transient and recurrent and more or less erratic, is dull and aching in character, increased by motion, and there is tenderness on pressure about the internal condyle about a half inch above the patella. Later on the knee is flexed on account of the spastic contraction of the muscles about the joint, and this flexion and the stiffness which accompanies it cause a practical shortening of the leg. The swelling is peculiar, it is uniform, giving a rounded appearance to the knee, the prominences becoming lost in the general rotundity, the swelling is doughy, not edematous, and feels as though the joint were full of a thick gelatinous material. The color of the joint is not such as usually accompanies an inflammatory condition, but there is rather a lack of color; the joint has a whitish hue with blue veins running over the surface, and the temperature, instead of being above the ordinary, is more likely to be below. Constitutional symptoms are present, but not to any marked degree.

The second stage is usually ushered in by the nocturnal cry, which is indicative of destruction in the bone. These night cries are characteristic of ulceration in the bone and have already been spoken of in considering the disease of other joints. The patient suffers from pain on

motion, the pain is exceedingly severe and the patient naturally dreads any motion; the tendency to keep the joint rigid is involuntary. Later on there is, however, what is an abnormal movement, which comes from the destruction of the inter-articular structures or those within the joint, and this allows passive motion to be made in unusual directions and is accompanied by a grating of the bones, or crepitus. The constitutional condition also evinces signs of advanced disease, as the fever, emaciation, debility, and all the symptoms which characterize a severe form of articular disease. At this, the third stage, the abscesses develop and the pus may burrow down under the tissues opening at a point considerably distant from the joint. This pus is like that which is found in all cases of tubercular joint disease and may be thin, serous and filled with large flocculent masses, and sometimes tubercular bacilli are found in it.



Fig. 297.  
Eversion of  
Foot in Knee  
Joint Dis-  
ease. From  
Plaster Cast  
By Sayre.

There are peculiar appearances which accompany the disease of knee-joint, as the eversion of the foot (Fig. 297) which is the result of the contraction of the ham-string muscles, with a tendency to pull on the outer head of the tibia and rotate the foot outward; also the flexion caused by the spastic contraction of the muscles, and the constant traction of these muscles induces a sub-luxation of the head of the tibia backward on the condyles of the femur. This gives rise to a peculiar overhanging appearance of the femur, making the joint appear much more prominent in front and the swelling apparently much greater than it actually is. There is decided shrinking of all the muscles above and below the joint,

this being one of the characteristic symptoms of the disease, and this shrinking of the limb adds to the undue prominence of the joint itself. The symptoms in the case of tubercular disease of the joint differ from those of an ordinary synovitis in that the onset of a synovitis is rapid and exceedingly painful from the first and is either the result of an injury or a cold, or perhaps of rheumatic or specific conditions, while the tubercular disease is exceedingly slow in its onset and lacks some of the symptoms of active inflammation. In the synovitis there are the rapid swelling, the great pain, the heat, the soft fluctuating tumor and absolute loss of function; in the tubercular disease in the early stages there is the lack of great pain, there is no heat, motion is limited, but not lost at first, and the swelling is "doughy." In some cases the disease may run its course without suppuration, or it may undergo cheesy degeneration and absorption without the formation of pus. If recovery takes place it occurs by a general remission of the constitutional and local symptoms, with increased appetite, better sleep and improvement in every other direction, and ankylosis will be the result. If the disease has progressed to a stage of suppuration where destruction occurs, there are all the symptoms which occur in any advanced tubercular disease,—night sweats, fever, loss of appetite, diarrhea, great exhaustion amyloid disease of the kidneys and general tuberculosis.

**Treatment.**—When a child shows the early symptoms of knee-joint disease the gravity of the situation should be explained to the parents and immediate steps should be taken to prevent further advance of the disease. As in all joint diseases, the principal thing to avoid is functional

activity. If a child with incipient knee-joint disease walks about every additional step excites the already existing inflammation, and the limb should be kept as quiet as possible and no weight should be allowed to be borne on it until the disease has disappeared. It is not always necessary to put a child to bed with disease of the knee joint, but he may have some form of splint



Fig. 298.

Double Extension of Sayre.

which will immobilize the joint and allow him to go about on crutches, with a high shoe on the opposite foot. The form of splint which may be used in this case consists of a simple poroplastic splint of felt, or one of leather (Fig. 301) or plaster-of-Paris, or perhaps a steel brace, which is arranged with straps to immobilize the joint. In tubercular disease, however, even immobilization alone is hardly sufficient to effect a cure. It has been found that tubercular bacilli do not develop at a low temperature, and as the knee-joint is easily accessible the continuous application of cold can readily be made to this vicinity; so that one of the best means of prevention of the tubercular development is by keeping the knee-joint constantly wrapped up in ice bags. These should be kept on continuously for weeks and even months. In one of the author's cases the application of ice was made continuously for over nine months with good result. This form of treatment is bothersome on account of the leaking of the ice bags and the constant attention which they require to keep them filled, and it is apt to be neglected unless the parents are thoroughly imbued with the idea of its necessity. Where the disease has progressed so that the patient suffers from pain it may be necessary to apply some form of extension. There are many forms of apparatus having this object in view. Sayre's is well known, but it is more or less difficult to apply, and to keep up the extension.

The best results are obtained by the same form of brace which is used in diseases of the hip-joint, because sufficient extension can thus be obtained and the patient can walk about without the use of crutches; and the treatment by this means is in every way much more efficient than by means of the short knee braces.



Fig. 299.  
Ankylosis  
Following Knee  
Joint Disease.

Application of iodine ointment may be applied, and should be rubbed in night and morning, just avoiding the blistering of the skin. The tincture of iodine is too strong; it causes blistering and hardening of the epidermis, which loses its powers of absorption, while the iodine ointment is much more readily absorbed and does not cause vesication. When the deformity appears with the eversion of the foot and the overhanging appearance of the condyles of the femur another form of extension must be employed, and the double extension of Sayre, which is used in bed, may be tried; or Stillman's knee brace with posterior spring and pad. If

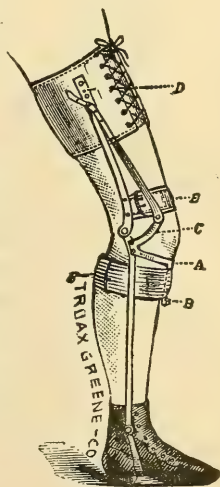


Fig. 300.  
Robert's Knee Brace.

an abscess appears then the etherial solution of iodoform in the method



already mentioned, or the use of iodoform and oil should be tried; or, if it is necessary to take more active measures, excision or erasion of the joint may be considered. If these are not sufficient the only remedy remaining may be amputation of the limb, which, of course, should be employed only as a last resort.



Fig. 301.  
Splint of  
Leather or  
Felt.

There are serious objections to excision of the knee-joint in a child. The epiphysial line is from three-quarters of an inch to an inch from the articular surface, and it is from the epiphysial line at the knee-joint that the longitudinal growth of the bones take place. If these epiphysial cartilages are removed the bone will cease to grow in length, or, at least, its growth will be very much interfered with. And if the head of the bones be seriously affected with tubercular disease it may be impossible to remove the entire

focus of the disease without removing the epiphysial cartilages. In two cases the author has been obliged to amputate at a point higher up after it had seemed that all the diseased portion of bone had been removed. If it is not removed sufficiently the disease re-appears in a short time, even though primary healing may apparently have taken place, and it is the only remedy. The operation of excision is easily performed. Beginning at the inner condyle the semilunar incision is carried down half an inch below the popliteal and to the corresponding bone on the opposite condyle. The patella or the flap including the patella is dissected up; the lateral ligaments are divided and the condyles of the femur and the head of the tibia are freed from their attachments. Then the head of the tibia and the condyles of the femur are sawed off so as to give a straight leg when the ends of the two bones are applied to each other. They may be fastened in position by steel nails, or by silver wire, or perhaps by kangaroo tendon. This tendon will last as long as is necessary in the tissues and will finally dissolve and completely disappear.

Fig. 303. Long Ankylosis Apparatus.

Fig. 303. Long Ankylosis Apparatus. A black and white illustration of a long, cylindrical apparatus, possibly a splint or a brace, with various straps and buckles. It is shown in a side view, with a small detail of a strap and buckle shown separately.

Fig. 304. Schematic Representation of Excision in Angular Ankylosis of the Knee. A black and white schematic diagram showing a cross-section of a knee joint. It illustrates the bones and the incision line for excision in angular ankylosis. The diagram is labeled with letters 'a' through 'f'.

Fig. 304.

Schematic Representation of Excision in Angular Ankylosis of the Knee.

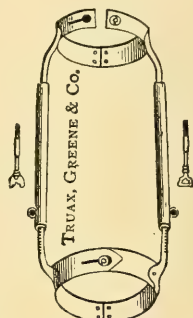


Fig. 302.  
Sayre's Extension  
Apparatus.



Fig. 305. Wedge-Shaped Excision in Right-Angled Ankylosis in the Knee; Before and After Operation.

Erasion is now considered more favorable to recovery than excision, but it must be done thoroughly. If the disease is cured by ankylosis and in

a bad position the excision of a wedge-shaped portion of the bone may be practiced.

In some cases tenotomy of the hamstrings may be all that is required to allow the leg to come straight. In some cases it is inadvisable to attempt any operation even though the limb is crooked. In such a case such apparatus as will aid the patient in walking should be used, and one which allows the weight to be supported by the thigh instead of by the ankylosed joint is the best.

In mild cases of fibrous ankylosis gradual extension by some form of apparatus may be employed.

## CHAPTER VIII.

### KNOCK-KNEE, OR GENU-VALGUM.

**General Conditions.**—Knock-knee is the term applied to a condition where the knees fall within a line drawn from the head of the femur to the ankle. Sometimes the knees may merely strike together; sometimes they overlap, or the ankles may be wide apart. This

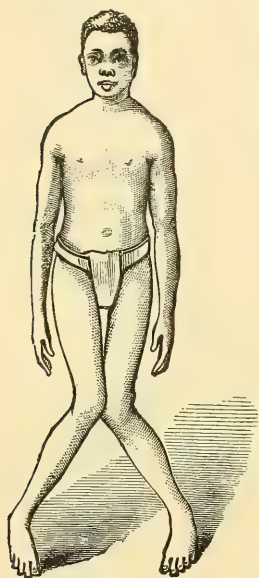


Fig. 306.  
Locomotion in case of  
Genu Valgum.

may result from two causes; either from an increase of growth of the inner condyle of the femur, or there may be a laxity of the internal lateral ligaments of the knee-joint which allows a space to exist between the inner condyle and the head of the tibia. When this laxity of the internal lateral ligaments is present continual pressure is brought to bear on the outer condyle of the femur, which results in preventing its development, while the lack of pressure on the inner condyle allows it to develop unduly. A rachitic curvature of the legs may also be the cause of knock-knee. It may exist in almost any degree, from a slight knocking together of the knees to the most exaggerated crossing of the legs, so that one knee crosses over the other, and the outside of the foot is in apposition instead of the inner side. Such a deformity is known as "scissor-legs." Knock-knee is almost always, in rachitic cases, accompanied by flat-foot, which is the result of weakened



Fig. 307.  
Knock-Knee

muscles on the anterior portion of the leg. It is usually found in children whose limbs are not fully or equally developed. Occasionally a strong, well-developed child will have knock-knee, but in such cases it seems to be due to an increased development of the condyles. The joints are exceedingly large and it is probably due to a rachitic tendency. Where the internal lateral ligaments are weakened it is due to a low tone of the system; the ligaments are lax, and on account of this laxity the leg may be moved laterally, so that a decided space may be found between the internal condyle and the inner edge of the head of the tibia.

**Diagnosis.**—The diagnosis is easily made. The patient is laid on



Fig. 308.  
Tracings of a case of knock-knee,  
without lines of condyles.—Brad-  
ford and Lovett.



his back, and the limbs are kept perfectly extended; any attempt to bring the ankles together may result in failure on account of the prominence of the knee-joint. But if the ligaments are very lax, or the deformity is not very severe, it may be accomplished. One may be easily deceived into thinking that the deformity may be easily reduced if the limbs are not kept perfectly extended because the increase in length takes place on the lower end of the condyle and not posteriorly, so that when the limb is slightly flexed another angle of the tibia with the femur is assumed and the leg becomes straight when viewed from the front; but when the extension is again made it will be found that the deformity has returned. This is a point of great importance, not only in making a diagnosis but also in the treatment. Where the case has gone on for a considerable length of time and the ligaments are strong it may be impossible to restore the deformity or obtain any lateral movement at the joint. In cases where the deformity

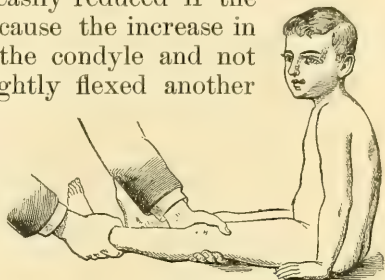


Fig. 309.  
Manual correction of knock-knee.  
—Hoffa.



Fig. 310.  
Before application  
of elastic traction.—  
Schreiber.

is slight it may cause little difficulty in locomotion; but if accompanied by flat-foot on one side and a normal condition of the limb on the opposite side it may lead to static curvature of the spine, as has been shown in the chapter on Lateral Curvature of the Spine. The gait of the patient may be rolling, on account of the difficulty of getting one knee past the other.

**Treatment.**—When occurring in young children, even in quite pronounced cases, the difficulty may be easily remedied if the constitution of the child is not greatly affected, for frequently this occurs in children who are apparently otherwise strong and hearty. This should be borne in mind in making a prognosis. Where there is no bending of the bones from rachitis the limbs can be straightened by the use of braces if attempts are begun when the patient is young; and often in cases where

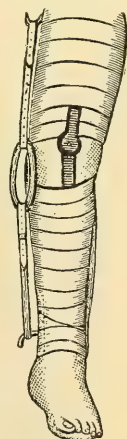


Fig. 311.  
Vogt's plaster  
bandage  
with elastic  
traction.—  
Schreiber.

the condition is a mild one it may be possible to restore the limb by manipulation alone. The simplest form of treatment is by means of massage, galvanism, and frequent applications of pressure to the condyles. This may be accomplished by putting the patient in the upright position, and taking a large flat cork or pad, about three-quarters of an inch in thickness, having it hollowed a little at the sides in order that these may act as receptacles for the condyles and placing this between the knees, with the ankles pressed together. This has a tendency to stretch the external lateral ligaments, while it relieves the laxity of the external lateral ligaments and brings pressure to bear upon the internal condyles. It should be done several times a day and the

patient allowed to stand for a few minutes in this position, care being always taken that the limbs are in a completely extended position and not in the slightest degree flexed when this application is made. If there is also a condition of flat-foot or any other manner of deformity present that should be attended to. In the more severe cases the application of a brace is called for. There are a large number of braces for the cor-



Fig. 312.  
Results of appli-  
cation of elastic  
traction. - Schrei-  
ber.

rection of this as almost every other deformity, many of which are excellent in their methods, and some of which are exceedingly faulty. The great difficulty with a large number of braces is that they consist of a combination of steel bars and straps which encircle the leg and are so arranged as to draw the leg toward the steel bar; this necessitates the passing of a band around the leg, especially around the knee-joint, and makes a pressure upon the popliteal space. Pressure at this point cannot help interfering with the nutrition of the limb, because it must press upon the arteries and vessels and cause more or less interference with the circulation. This is a serious fault, and on account of this difficulty it is often impossible to keep up the continuous pressure on the inner side of the joint.

Various means have been employed to remedy this defect in the braces, but it is impossible to do so with straps passing around the limb, or to gain pressure of any service on account of the pain which is caused by the pressure in the popliteal space. Another thing which must be borne in mind in the treatment of this difficulty is that whatever form of brace is placed upon the patient's limb he is made to walk about with the knee perfectly straight; the limb must be rigid from the hip to the ankle, because the moment the leg is allowed to be flexed it brings it into a different line and in a place where pressure is not brought upon the internal condyle. For this reason braces which have the effect of keeping the leg perfectly straight are the ones which should be used, but it is necessary at the same time that the patient should be allowed to move his limbs at certain times during the day. The joint cannot be maintained in a stiff position constantly, nor can the brace be always removed to easily accommodate the necessity for moving the joint. It is better if the braces are worn constantly, night and day, although that will not be tolerated by some patients. Where it cannot be done they should be worn at all times when in an upright position. In order to facilitate this treatment and keep the brace on at all times it is necessary to have it arranged in some way so that the shoes and stockings may be removed and the brace left in position. Also, in order to gain sufficient pressure,

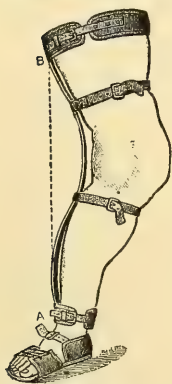


Fig. 314.  
Knock-Knee Brace.

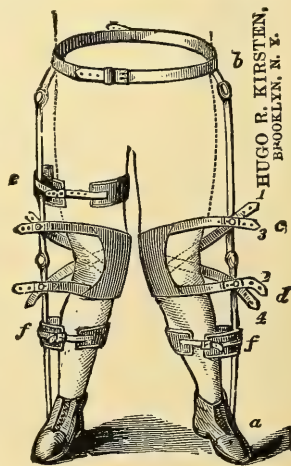


Fig 313.  
Double Brace.

Some patients are unable to tolerate the pressure of the brace, and in such cases the brace should be removed at intervals. It is better if the braces are worn constantly, night and day, although that will not be tolerated by some patients. Where it cannot be done they should be worn at all times when in an upright position. In order to facilitate this treatment and keep the brace on at all times it is necessary to have it arranged in some way so that the shoes and stockings may be removed and the brace left in position. Also, in order to gain sufficient pressure,



it is necessary that braces should run from the pelvis to the ankle; short braces have very little effect as the brace cannot gain sufficient leverage without being applied very tightly. The best brace is one which is made to use without pressure from the straps which encircle the limb, but which takes its pressure from a brace on the inner side of the limb, and one in which the leg can be perfectly loose except at the points where the pressure is made, that is, at the outer side of the leg and thigh and across the inner condyle.

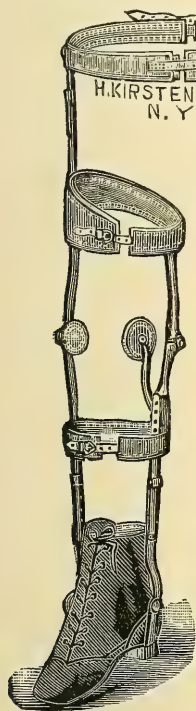


Fig. 315.  
The author's knock-knee brace.

To obviate the various difficulties which have presented themselves from time to time in treatment of cases of this sort which come under notice the author has devised a brace which he thinks meets the requirements. It consists of a pelvic band with a bar running along the outer side of the limb, fastened to the shoe; this bar is jointed at the hip, knee and ankle; on the inner side of the limb is also another bar, but shorter, as it cannot be attached to the pelvic band; this is united to the external bar by semi-circular bands above and below the knee, and is also attached to the shoe; one or two straps encircle the limb loosely, these being necessary to hold the bars in position. Pressure is made against the knee-joint by means of a lever and pad which spring out from the internal bar, the pressure being regulated by means of a screw so that any amount of pressure desired can be brought upon the joint. The joints at the knee may be locked by means of a short bar of steel which is so arranged as to hold them in a straight position, the knee being held straight by means of a knee-cap. By this apparatus it is possible to gain any amount of pressure desired; the patient can walk about with the knees in a straight position, and there is no pressure at all on the popliteal space, while by removing the steel lock-bar at night, when the patient is lying down with the splint applied, he may be allowed to bend his knees as frequently as desired. As before remarked, it is better if the patient wears the brace night and day, but in case he does not the apparatus described can be used during the day or whenever the patient is in an upright position. The author has been able to cure severe cases in young children inside of three or four months with this apparatus. Others, on account of the irritability of the child and the lack of discipline on the part of the parent, frequently require a much longer period. This brace has always been found exceedingly satisfactory, and in cases which are curable by braces it is believed it is as good as any form



Fig. 316.  
Unilateral knock-knee before Osteotomy.



of brace made. Of course, the application of massage and electricity and the general treatment of the patient's condition must be attended to carefully at the same time. In the more severe cases, in which the bones have become hardened and the ligaments strongly contracted, and perhaps accompanied by some deformity of the bones themselves, it may be necessary to resort to more radical measures, and either osteoclasis or osteotomy may be required.

**OSTEOTOMY.** Where a curvature of the bone exists from a rachitic condition this form of treatment will become absolutely necessary after hardening of the bones has taken place, and where there is a decided length of the internal condyle which has persisted beyond the time when treatment by means of the braces is of avail osteotomy should be performed. This is, as a rule, a safer, more expeditious and surer treatment than osteoclasis, because where the chisel is used the bone can be divided exactly at the point where the operator desires; but where the machine for fracture is applied other structures besides those upon which the operation is performed may be injured, and it may not be so easy to fracture the bone at exactly the point where it is desired. The advantage of breaking the bone is that there is no external wound; though with antiseptic precautions very little danger may be apprehended from the use of the chisel. Various points may be selected for the division of the bone but the most frequent one is about one inch to one-half inch above the

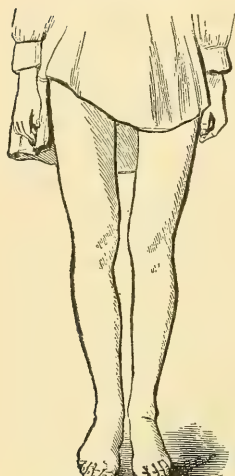


Fig. 317.  
Unilateral knock-knee  
after Osteotomy.

joint, through the internal condyle. The limb is rendered aseptic, then it is placed on two or three sand-bags, so that it is perfectly imbedded and rendered perfectly solid for the use of the chisel. The incision through the skin may be made with the knife, or the entire operation may be performed by the chisel. These chisels or osteotomes are of different sizes and thickness. After the incision is made through the skin down to the bone the chisel is applied at the point desired and driven by the mallet down into the bone as far as is necessary. As a rule it is unnecessary to drive the chisel clear through the bone, because when the bone is partly cut through it may be bent into shape, or the fracture completed by the pressure of the hands. Sometimes it is difficult to get the chisel out of the bone because it has become wedged in place, when great care must be used lest the chisel be broken off; it must be pulled out in a straight line, or, if it must be moved from side to side to loosen it, it must be done edgewise.

The directions given by Macewen are to withdraw the chisel by means of pressure of the hands, by grasping it as close to the limb as possible, and then by shutting the hand tightly, the pressure caused by the contraction of the muscles will tend to raise the chisel out of the groove. The "V"-shaped

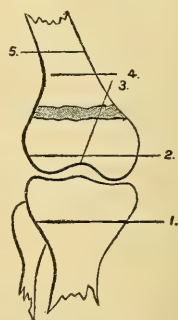
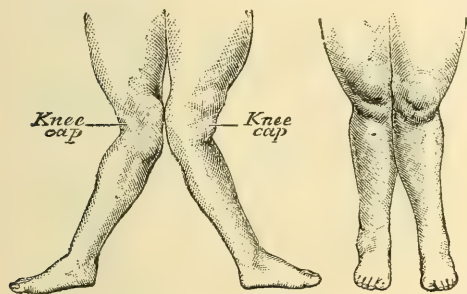


Fig. 318.  
Lines of incision  
Osteotomy for  
knock-knee. 1.  
Mayer, Billroth,  
Schede; 2. Annan-  
dale; 3. Ogston,  
Reeves, Chene; 4.  
Macewen; 5. Tay-  
lor.

opening in the bone caused by the entrance of the chisel is usually sufficient, without removing more bone, to have the limb brought around in a straight position, and it is on this account that the application of the chisel is made to the internal condyle rather than the external. It is well during the operation to have a stream of bichloride solution constantly played upon the part, so that no germs can enter into the wound. The bleeding is sometimes profuse for a few moments, but as no vessel of any size is cut it is soon stopped by pressure. After the removal of the chisel the limb is brought into correct position; a piece of iodoform gauze is applied directly over the opening of the wound, and this is covered with antiseptic dressing. The limb should then be placed in a straight position, and a plaster of Paris bandage applied. The author always employs the plaster of Paris bandages wet in 1-2000 solution of bichloride of mercury;



**Figs. 319 and 320.**

Appearance of limbs before and after Macewen's operation in a patient aged thirty-three. The legs and feet rotated outward and abducted.—Bryant

this makes a perfect aseptic bandage and need not be removed for ten days or two weeks, or perhaps five or six weeks if it is necessary to retain it so long. The author's belief is that plaster of Paris makes as perfect an aseptic dressing as can be procured, not only from the aseptic qualities of the plaster itself, and the bichloride of mercury which is used in moistening it, but, because of the stiffness and immobility of the dressing, healing tends to progress with great rapidity. If swelling or inflammation occurs it may be necessary to split the dressing down the front or on the inside of the limb. As a rule this will not be necessary because a plaster of Paris bandage instead of shrinking becomes slightly larger as it dries, the result being that there is more room after the splint is thoroughly dry and hard than when it is wet. Frequently by lifting the limb the force of gravity is sufficient to prevent any congestion of the extremity; but rather than run any risk it is better to slit the bandage and then afterwards perhaps apply another layer of plaster of Paris, which will retain the splint in position, although a little looser than it was originally.

## CHAPTER IX.

### GENU VARUM OR BOW-LEGS.

**Pathology.**—In this condition the knee-joint falls outside of the line drawn from the head of the femur to the ankle, or where an outward curvature, more or less pronounced, exists in the bones of the leg or thigh. In some cases the bones may be straight, but if the deformity be due to an increase in the length of the outer condyle of the femur the joint makes an outward angle instead of a curve. Bow-legs is a condition essentially the result of rachitis. The curve in the bones may exist in the tibia and fibula or the femur, or all, and may vary from a slight curvature of one bone to a very pronounced curvature of all the bones of the lower limb. Sometimes the curve is so great as to almost form the letter “O,” the two limbs being symmetrically curved.



Fig. 321.  
Genu Recurvatum.

**Causes.**—Different causes have been assigned for the presence of bow-legs, but it is generally considered that the effort of standing when the bones are inclined to be rachitic is the usual cause. In some cases the legs have been found bowed before the child commenced walking, supposed to be due to the fact that strong muscular contractions have bent the bone; but these cases are rare, and in almost all cases the curve appears at about the time the child begins to stand. The gait of a bow-legged child is

peculiar; he walks with the feet wide apart and the knees flexed; the toes may be turned in and lordosis of the spine may also be present, and he walks with an awkward gait. Occasionally, but very seldom, there will be genu varum on one side and genu valgum on the other, but such cases are exceedingly rare. Occasionally there is anterior bowing of the tibia. The period of increase or decrease of the bowing of a child's legs is during the first four years of his life. The bones are soft and take shape according to the direction in which the bone yields most readily. This softening may continue up to about the age of four years, when the bones become hard. After that time there may be excessive hardening of the bone, or “eburnation.” In this condition the bone becomes harder than normal and it is utterly impossible to expect a change in the shape of the limbs after this period, or to straighten the bones by means of braces.

**Treatment.**—For some unknown reason some cases of bow-legs get well spontaneously at an early age, but no data can be given by which one can decide that a case will continue in the deformed condition or that

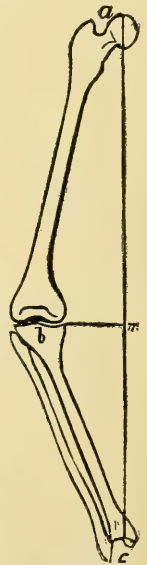


Fig. 322.  
Showing degree of curve.



the legs will become straight without treatment, so that it is always better, in order to be on the safe side, to begin the treatment at as early an age as possible. In order to keep a record of the progress of the case it is well to make a drawing of the child's limbs. This can be done by setting the child down on a piece of paper and making tracings of the limbs as they are pressed down. Further tracing can be taken from time to time which will indicate the increase or decrease of the deformity. During the bowing age, or between three and four years, much may be expected by the use of braces, and we may, as a rule, offer the hope that the case will be cured by braces alone; but after that age nothing farther can be accomplished by this means and only operative measures will be of any service.

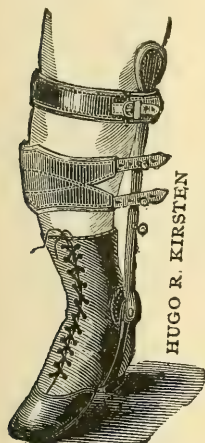


Fig. 323.  
Bow-leg brace.

There are several varieties of braces which can be used, the object being to make continuous

pressure upon the curve and by this pressure to pass the limb inward. These should be applied as early as possible and kept on until the limb is straight. As a rule where the bone is bent anteriorly in the tibia it is much more difficult to affect it by the use of braces, but sometimes if the treatment is begun quite early a good deal may be accomplished. The general health and the improved nutrition of the patient have much to do with the progress of the disease, and as rachitis is essentially a condition of malnutrition, it is probable that under improved hygienic conditions and the improvement of the patient's general health a change in the bone formation may be brought about, so that the correction of the deformity is more easily effected. It is a question how much may be accomplished by remedies and food and it is well to bear in mind that certain drugs may have the effect of producing rachitis. Heitzman has told us that he has produced rachitis in rabbits by giving them lactic acid for a prolonged period, and it is possible that there are other remedies that have the same effect. We know that silica and calcaria and certain other "tissue remedies" have a curative effect on the tendency of rachitis. The operative treatment may consist of osteoclasis, osteotomy or osteostomy. Osteoclasis consists of breaking the bone and restoring it to the correct position. This may be done by

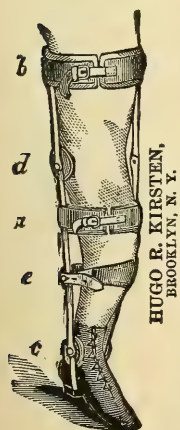


Fig. 325.  
Bow-leg brace.

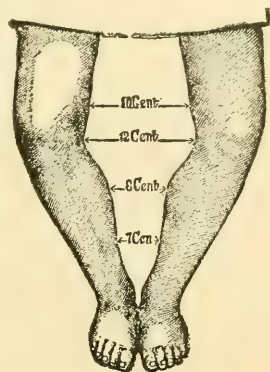


Fig. 324.  
Genu Varum.



Fig. 326.  
Anterior curvature of bones  
of legs.—Ashhurst.

the hands, or it may be accomplished by any of the various forms of osteoclasis.

Manual osteotomy is not as accurate as with the use of osteoclasis, because it is impossible to regulate the force with such certainty as with the use of the apparatus; still it may be tried in cases where it is inconvenient or inexpedient to have the osteoclast. The osteoclast most frequently used is that of Risoli. It consists of a heavy steel bar with two rings and a central screw between them, which has a pad attached to its end and which may be made to press into the tissues and against the rings in such a manner that pressure will be brought on three points of the bone, which is fractured by the pressure of the screw. With this osteoclast the pressure may be regulated exactly and the fracture takes place at the point desired by the operator. There are other forms but none of them which have any special advantage over the one mentioned. After the fracture the limb should be placed in a retentive dressing—plaster of Paris being generally used and the best. The after-treatment may be considered as being about the same as the treatment of any ordinary fracture of a long bone and should be carried on on about the same principles. The operation of osteotomy should be performed with the utmost antiseptic precautions. The limb should be placed upon a sand-bag and the osteotome intro-

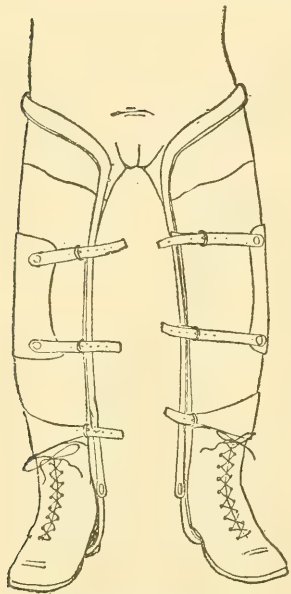


Fig. 327.  
Apparatus for bow-legs.—  
Bradford and Lovett.

duced at the point where the fracture is required; an incision may be made first longitudinally through the soft portions, the chisel introduced down to the bone, and then turned so that its edge is across the bone. The mallet is then applied until it is found that the bone has been cut through. It is not always necessary to completely sever the bone with the chisel, but only to cut it sufficiently so that the remaining portion can be fractured by the hands.

The operation of osteostomy is performed by the removal of a wedge-shaped piece of bone from the convexity, sufficient to allow the legs to be brought into straight position. In order to determine the amount of bone which should be removed the child may be seated on a piece of paper, as already described, and a drawing made of the limbs; afterward from the convex side a "V" shaped piece may be removed until the tracing can be brought straight. This will give an approximate idea of how much of a wedge should be removed from the bone. As a rule, however, it is very seldom necessary to perform osteostomy, osteotomy being sufficient; but in the anterior

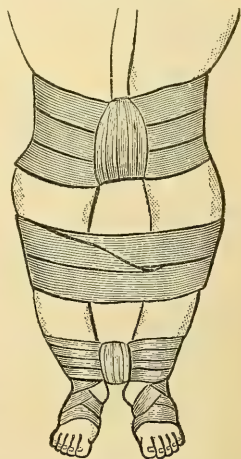


Fig. 328.  
Rubber bandage for  
bow-legs.—Davis.

curvature of the tibia this operation occasionally has to be resorted to. After the operation the limb should be placed in plaster of Paris bandages and maintained there until healing has taken place, which

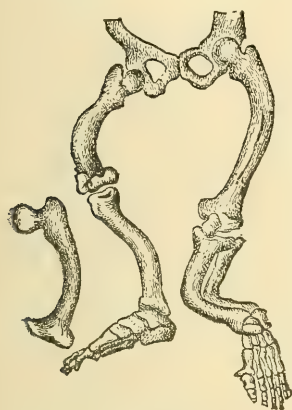


Fig. 329.  
Rachitic Curvature of the  
limbs.

usually occurs by first intention. Occasionally, through some dyscrasia of the patient, or possibly from impossibility to keep the child quiet, the union does not take place and a false joint results. This occurred in one of the author's cases in the Laura Franklin Hospital. The boy was unruly and in spite of all attempts to keep him quiet would insist upon using his leg. The result was that failure to unite occurred. At a later period the bone was cut down upon and the two fragments wired together. At that time no attempt, apparently, had been made to unite the ends. No callus had been thrown out and the ends of the bone had become somewhat conical in shape. The wiring was not effective and no good resulted, although the wound healed by first intention, and the child was kept in the hospital for about a year. Finally, by the use of Esmarch's band passed lightly about the limbs at a point above the seat of fracture the return circulation was somewhat impeded and the blood kept in the part longer than ordinarily, and by this means the nutrition was increased, when after a long time union took place. This fact, of course, must always be borne in mind in dealing with these cases; but such a result is so unusual that it may be practically ruled out in considering the prognosis of operation.

usually occurs by first intention. Occasionally, through some dyscrasia of the patient, or possibly from impossibility to keep the child quiet, the union does not take place and a false joint results. This occurred in one of the author's cases in the Laura Franklin Hospital. The boy was unruly and in spite of all attempts to keep him quiet would insist upon using his leg. The result was that failure to unite occurred. At a later period the bone was cut down upon and the two fragments wired together. At that time no attempt, apparently, had been made to unite the ends. No callus had been thrown out and the ends of the bone had become somewhat conical in shape. The wiring was not effective and no good resulted, although the wound healed by first intention, and the child

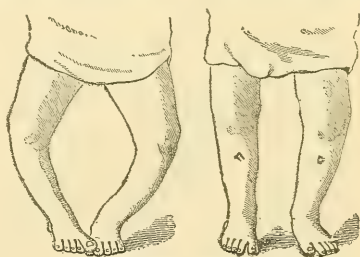


Fig. 330.  
Result of osteotomy for bow-legs.—  
Ashhurst.



## CHAPTER X.

### TALIPES, OR CLUB-FOOT.

**Definition.**—Talipes is a permanent deviation of the foot from its normal anatomical relations with the leg. “This abnormal position may consist of flexion, extension, inversion or eversion or a combination of one or more of these, but is popularly applied to that deformity in which the

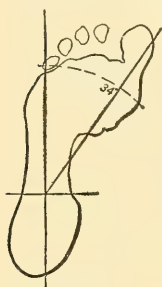


Fig. 331.

Angle of Deflection, Normal Male Feet. Roberts.

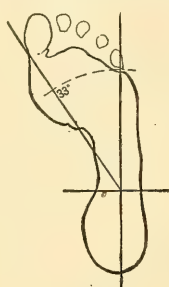


Fig. 332.



Fig. 333.

Angle of Deflection, Normal Female Feet.

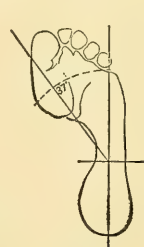


Fig. 334.

foot is twisted inward so that the weight of the body is turned on the outer side or dorsum of the foot” (Young). In speaking of the position of the foot reference is made to the position of the sole. If the

foot is said to be turned outward it is understood that the sole looks outward, and vice versa; so that in describing the various deformities of the foot it is understood that the sole of the foot is always the part to which reference is made in speaking of the presenting surface. The different simple varieties are:

**TALIPES-VARUS.** (Figs. 337, 341, 343).



Fig. 335.

Angle of External Deflection in Valgus.—Roberts.



Fig. 336.

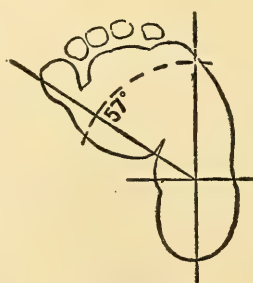


Fig. 337.

Angle of Abduction in Varus.—Roberts.

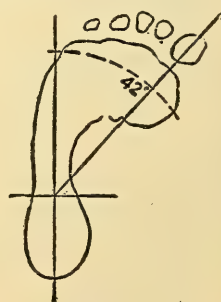


Fig. 338.

In this variety the foot is turned inward and the patient walks on the outside of the foot.

**TALIPES VALGUS.** (Figs. 336, 345, 344, 347.) The foot turns outward and the patient walks on the inside of the foot.

**TALIPES EQUINUS.** (Figs. 348, 349, 350, 352.) The heel is drawn up and the patient walks on the ball of the foot.

**TALIPES CALCANEUS.** (Figs. 353, 358, 363.) The anterior portion of the foot is elevated and the patient walks on the heel.

**TALIPES PLANUS.** The arch is dropped and the foot is flat.

**PES CAVUS.** The arch is greatly exaggerated and the foot practically shortened. (Fig. 359.)

Almost any combination may exist, the name of the one most prominent in the deformity taking the precedence, as talipes equino-varus,

calcaneo-varus, equino-valgus, etc. (Figs. 360, 361.)

**Causes.**—Talipes may be either congenital or acquired. When congenital it is sometimes inherited and has been known to afflict families for two or more generations. The children of consanguineous marriages may be afflicted

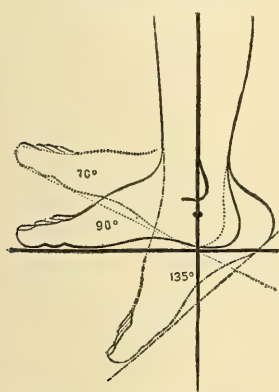


Fig. 339.

Diagram illustrating Range of Motion in Normal Foot.



Fig. 340.

Infantile Talipes Varus.

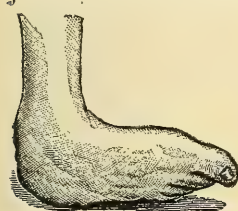


Fig. 341.

Congenital Talipes Varus | in a Man of 26.

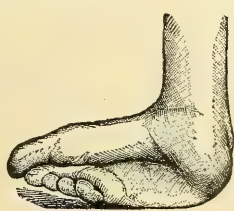


Fig. 342.

The Same, Seen Posteriorly.—Adams.

ment is supposed to be one of the causes, and the theory of retarded rotation of the fetus is now favored by prominent

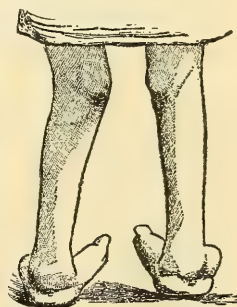


Fig. 343.

Aggravated Talipes Varus.

authorities. What the etiology of congenital talipes is is not determined, the theories regarding pre-natal influences are too vague and shadowy to afford ground for scientific belief. Whether intra-uterine pressure, or mal-position in utero or some condition of innutrition is the cause

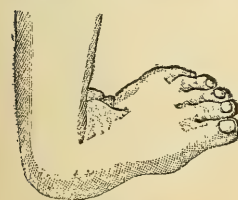


Fig. 344.

Acquired Talipes Valgus.



Fig. 345.

Congenital Talipes Valgus.

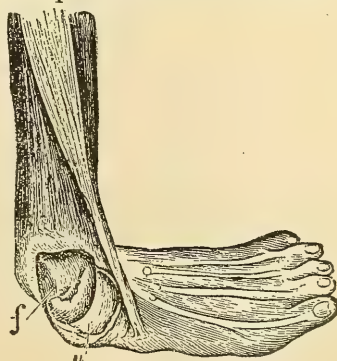


Fig. 346.

Congenital Talipes Valgus.

of congenital talipes it is difficult to say. We only know that some children are born with talipes. Most cases of talipes are the result of

paralysis of certain muscles or groups of muscles. In some the contracted muscles have undergone structural change so that it is impossible to reduce the deformity; in others the contracting muscles are simply

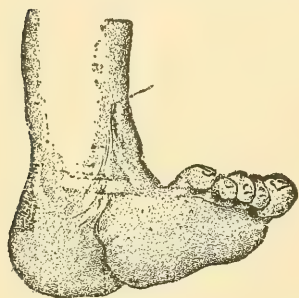


Fig. 347.  
Traumatic Talipes Valgus



Fig. 348.  
Talipes Equinus.



Fig. 349.  
Equinus.

using normal force to draw the foot from its correct position. The opposite muscles, having lost their tone, yield to the muscles which contract with their normal strength.

The deformity consists in a dislocation inward of the anterior part of the foot at the medio-tarsal joint as shown by Sayre. An alteration of all the tissues



Fig. 350. Fig. 351. Fig. 352.  
Aggravated Instances of Talipes Equinus.

takes place, due to the abnormal displacement. In congenital cases the muscles are contracted so that it may be impossible to restore the foot to the normal shape. "The muscles are never found paralyzed in congenital club-foot, but the contracted muscles seem more developed than the lengthened muscles." (Bradford and Lovett.) In congenital

cases the articulations are irregular, as the scaphoid with the inner and under side of the astragalus, and even with the tip of the internal

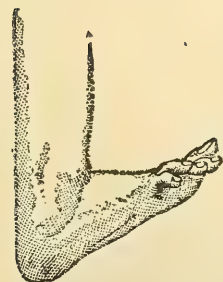


Fig. 353.  
Talipes Calcaneus.

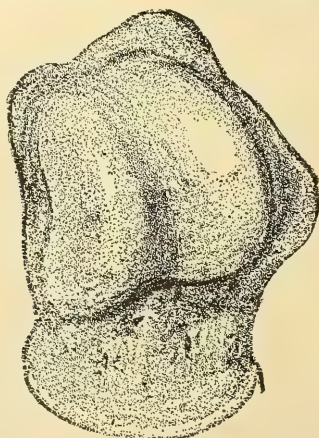


Fig. 354.  
Astragalus of an Adult.



Fig. 355.  
Astragalus of an Adult Talipes Varus.

malleolus. The dislocation of the scaphoid carries with it the rest of the bones anterior to the medio-tarsal joint, so that the whole anterior portion of the foot is twisted inward. In later life, from



long continued pressure, the position and shape of the scaphoid, astragalus, cuboid and os calcis may all be changed. The tendons are abnormally placed.

In old cases much pain is caused by inflammation, pressure and suppuration of synovial bursæ, which form on the outer and posterior portion of the foot, and also from the corns and callosities caused by pressure on the skin in walking. The



Fig. 356. Fig. 357.

Talipes Equinus, Paralytic.

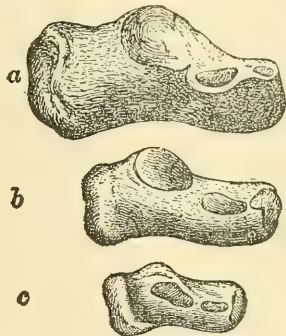


Fig. 358.

a. The Calcaneus Talipes Varus at one year; b. The Calcaneus, Normal, in the New-born; c. The Calcaneus Pes Varus in the New-born.



Fig. 359.

Talipes Cavus.

ligaments are changed and contracted and hold the bones in their abnormal position.

The acquired cases are usually the result of "infantile paralysis." Where it occurs as the result of this disease the paralysis may come on

suddenly with very few premonitory symptoms. The child may have had a fever which did not appear to have

any especial significance but may have continued for three or four days and possibly have been accompanied by con-

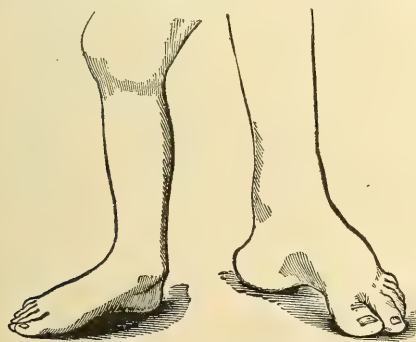


Fig. 360.

Talipes Equino-Valgus.

Fig. 361.

Talipes Calcaneo-Varus.

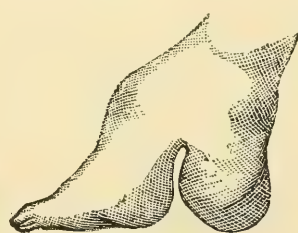


Fig. 362.

Foot of a Chinese from a Preparation in the Hun-terian Museum.

vulsions, - resulting in paralysis of the

limbs. This is due to lesions of certain nerves and inhibits the action of the muscles which they supply. Sometimes the history is very simple. The child goes to bed apparently well and in the morning it awakens with inability to use one or both limbs. Occasionally the disease is progressive; one limb may be affected, then two or more; or the leg on one side and the opposite arm be affected; almost any variety of combination of symptoms may exist. The child usually improves after the first onset of the disease, until perhaps only one limb or a portion of one limb may be affected; or the result may be much more grave, and both lower limbs, or even all of the limbs, may be affected permanently. This condition of paralysis may follow exanthematic diseases, such as

scarlet fever, measles, whooping cough and particularly cerebro-spinal meningitis. Among the causes of the acquired forms are rachitis, injuries to the ankle-joint, burns, which are followed by extensive cicatricial contraction, and some cases of pseudo-hypertrophic paralysis.

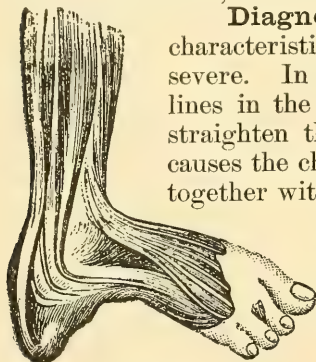


Fig. 363.

**Talipes Calcaneus.**—After Nicoladoni.

**Diagnosis.**—There are certain conditions which are characteristic of talipes. The congenital forms are the most severe. In some of these cases there are deep creases or lines in the sole of the foot, and if an attempt is made to straighten the foot it becomes very much congested and causes the child pain and reflex contraction of the muscles, together with great difficulty in or impossibility of straightening the foot. Here contracture of certain muscles has taken place before the birth of the child. In mild cases, by careful manipulation, the foot may be easily restored to the normal condition, but the moment the pressure is relaxed the foot goes back to the deformed position. In this case there is simply weakness of the muscles on one side, with normal contraction of the muscles on the other.

In very young children there may be no appearance of muscular atrophy, the limbs are well-rounded and do not present the appearance of lack of nutrition which occurs later on. If the case is one of an older child the appearance may be more characteristic. There may be shrinkage of the affected limb. If only one limb is affected it will be smaller and shorter than its fellow; the calf of the leg is straight, not rounded and full as on the opposite side. In paralytic cases the foot has a clubbed appearance, may be blue and cold from lack of circulation, with large callosities on the side of the foot on which the patient bears his weight. The patient walks with a rolling gait and with more or less difficulty; in the more severe cases still the limb may be absolutely useless and the patient have no power of locomotion at all. If he attempts to stand on the affected limb he is powerless and likely to fall. In mild cases it may be very easy to restore the limb to its proper position, but the moment the pressure is removed the deformity returns, while in others the contracture is so firm and so fixed, and



Fig. 364.

**Manual Correction of Club-foot.**—Hoffa.

the structural change which has taken place in the foot is so great that it is utterly impossible to bring the limb to a correct position. Interference with the circulation is due to the enervation of the parts; the arteries become smaller and carry less

blood than they should, and thus the nutrition is impaired.

**Treatment.**—In mild cases of congenital talipes much may be done by simple manipulation and straightening of the limb by the hands of

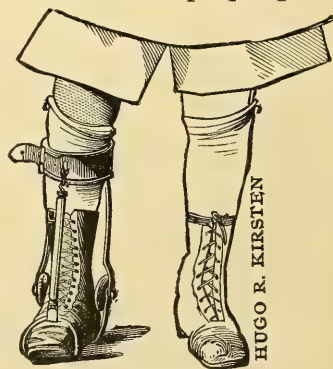


Fig. 365.

**Club-foot Shoe with Elastic Traction.**

the nurse or mother. This should be done several times a day, attempting at each trial to bring the foot to the correct position. These manipulations may cause reflex contraction and it may be impossible to straighten the foot if the pressure is made suddenly; but if the nurse is

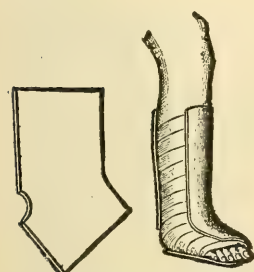


Fig. 366.

Felt Splint. (After Konig.)

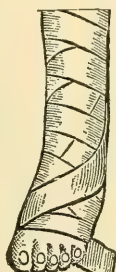


Fig. 367.



Fig. 368.

sufficient. In slight cases there may exist in the mind of the accoucheur a doubt as to whether talipes exists in the infant, when the test which is given by a French surgeon may be of assistance: If a child is undressed

and held with its back to an open fire, if there is a normal turning in of the foot the child will turn the soles of the feet towards the warmth of the fire, bringing them into correct position; but if it is a case of true talipes varus it will be unable

to do so, and the deformity will remain uncorrected.



Fig. 369.



Fig. 370.



Fig. 371.



Fig. 372.

Vogt's Club-foot Felt Splint.

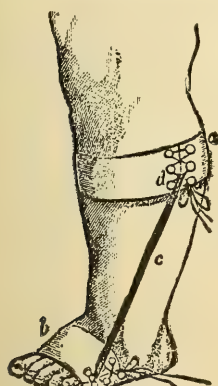
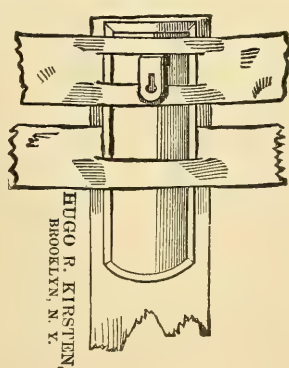
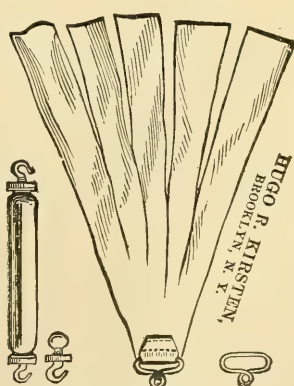


Fig. 373.

Elastic Traction.—After Willard.



HUGO R. KIRSTEN,  
BROOKLYN, N. Y.



HUGO R. KIRSTEN,  
BROOKLYN, N. Y.

Figs. 374 and 375.

Barwell's Elastic Traction Apparatus.

Wherever talipes is shown to exist the case should be placed in



the hands of a surgeon as early as possible, and in order to correct the deformity the foot should be placed in some form of retaining apparatus. This may consist of plaster of Paris splints, or felt, leather, or wooden splints, any of which may be moulded exactly to the shape of the foot.

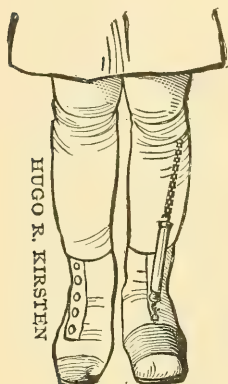


Fig. 376.

Elastic Traction Shoes.

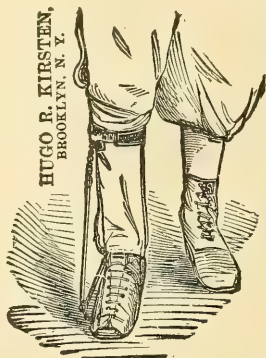


Fig. 377.

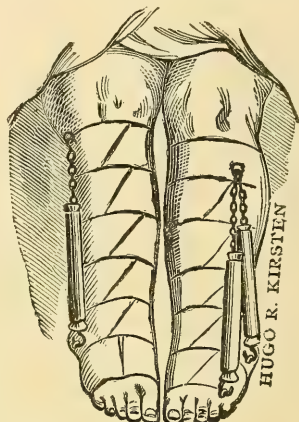
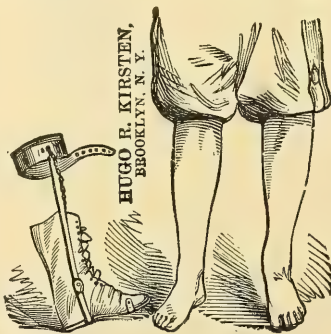
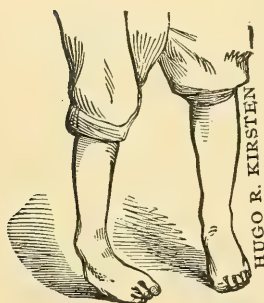


Fig. 378.

Elastic Traction.

The advantage of the plaster of Paris is that it can be moulded to the foot, which is maintained without difficulty in the corrected position. The disadvantage is that it must be kept on constantly and cannot be removed for the purpose of daily manipulation or massage. The splints

which can be made of leather or of felt do not have this objection, as they can be removed at any time and the massage of the foot be carried on, the nutrition being thereby improved.



Figs. 379 and 380.

Showing Effect of Correction Apparatus.

Where the plaster of Paris splints are used they should be frequently renewed, because while the deformity is in part corrected at one sitting and still more at the next, the advantage which is gained at one time should be followed up as rapidly as possible, in many cases a foot which may be very much misshapen at birth being brought around to a correct position. Where the leather or felt splints are used they may be removed every day. The foot should be bathed, rubbed and electricity applied to the weakened or paralyzed muscles so that the foot is straightened, and, at the same time, its growth is not prevented. When the deformity has been corrected, which may be accomplished at any time before the child begins to walk, some form of corrective apparatus should be applied. A form of club-foot shoe is the best, something which has an elastic traction tending always to bring the foot into the normal

position. Barwell's method of applying straps of adhesive plaster with artificial muscles of rubber has been avocated for use in the early stages, but has certain drawbacks. The skin of the child is so delicate that it is difficult to make the application of adhesive straps without causing

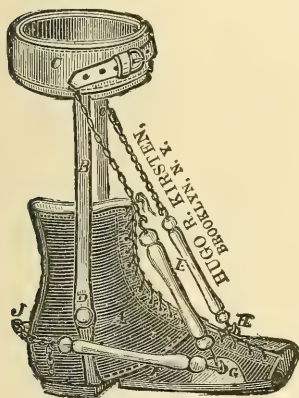
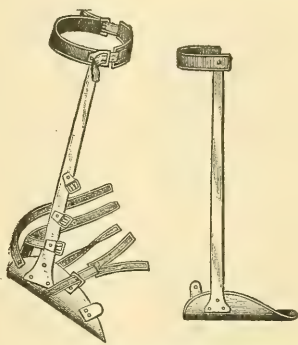


Fig. 381.  
Sayre's Shoe.



Figs. 382 and 383.  
Judson's Walking-brace for Equino Varus.

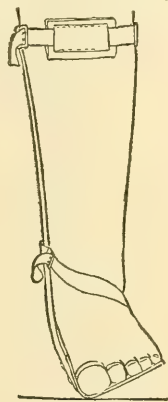


Fig. 384.  
Judson's Varus Walking-brace.

excoriation of the skin, and other forms of treatment seem preferable.

The variety of shoes which may be applied so that the patient can walk about are many. In some of them there are very ingenious arrangements of keys, pivots, ratchets, straps, joints, splints and artificial muscles, all of which more or less resemble the instruments of torture found in the Tower of London, and are equally efficacious in producing pain and discomfort unless applied by skilled hands. The simpler the form of apparatus which can be utilized in the treatment of these deformities the better, because where these complicated instruments have to be

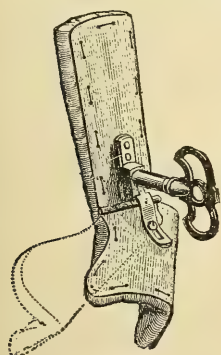


Fig. 385.  
Shaffer's Lateral Splint for Club-Foot.

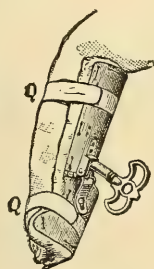


Fig. 386.  
Shaffer's Lateral Splint Applied.

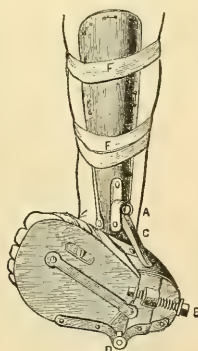


Fig. 387.  
Shaffer's Modification of Taylor's Ankle-Brace.

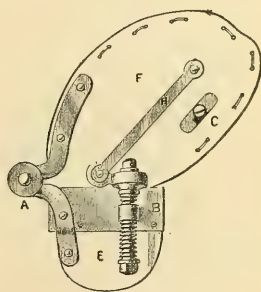


Fig. 388.  
Divided Sole-Plate of Shaffer's Equino-Varus Brace.

applied much pressure has to be brought to bear upon the limb, and thus the nutrition is still further impaired. It is of the greatest importance to apply some form of apparatus as soon as the child is old enough to walk about. The general health depends largely upon exercise and freedom of movement, and if this is restricted the child becomes fretful, irritable, and general depression of the system is likely to follow. As

auxiliaries to the treatment the application of massage, warm baths, dry heat, the use of electricity—especially of galvanism—to the motor points should be faithfully kept up. In advocating the use of electricity it should be understood that it is to be used with great care and skill. Electricity

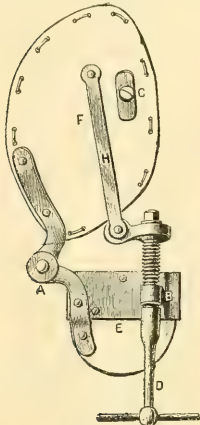


Fig. 389.

Sole-Plate Extended.

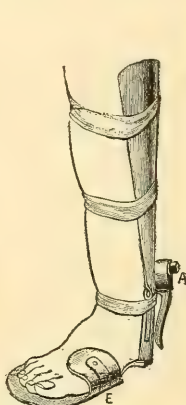


Fig. 390.

Brace Adjusted to Correct Position.

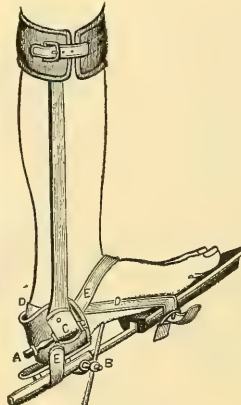


Fig. 391.

Shaffer's Extension Equinus Brace applied, Showing Action of Heel-Strap.

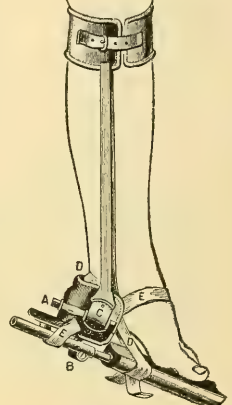


Fig. 392.

Shaffer's Extension Equinus Brace Applied to Foot in Deformed Position.

is one of the most potent agents we have in the treatment of these cases, but its misuse gives rise to great damage and retards the ultimate cure of the case. The application of the ordinary battery in a case of this sort is worse than useless, and electricity should not be applied without the advice of one who thoroughly understands it. Frequently it will be

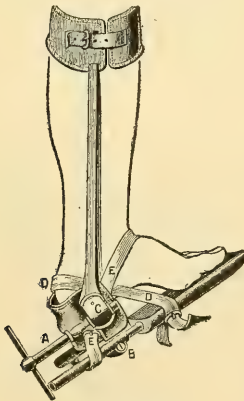


Fig. 393.

Shaffer's Extension Equinus Brace Applied, showing Tendency of Heel to Slip Away.

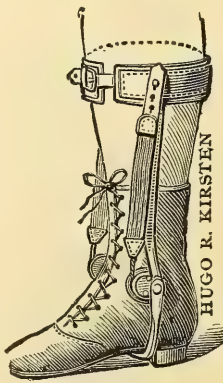


Fig. 394.

Shoes for Talipes Equinus.

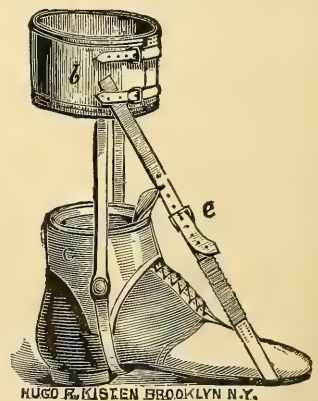


Fig. 395.

found that certain muscles or groups of muscles are paralyzed while the entire limb is not affected, and by the application of electricity to the motor points of these muscles the foot may be drawn into proper position. A careful expert examination of these cases is positively necessary, and a perfect understanding of the conditions present is most important.



The groups of muscles should be carefully tested from their motor points and those which are weak should be strengthened and their nutrition increased until they are equal in action to the healthy muscles. In some cases it may require long-continued treatment before it can be ascertained that there is any contracting function remaining in the muscles, but by care and perseverance faint contraction may finally be elicited, and if this is possible the restoration of the muscles to their proper use is feasible. In cases where contracture of certain muscles has taken place and the deformity cannot be reduced by manipulation the only relief that can be found is in some form of operation.

**TENOTOMY AND FASCIAOTOMY.** In many cases the operation of tenotomy or fasciaotomy may be required. In cases of talipes equinus a division of the tendo Achillis will allow immediate correction of the deformity. In cases of talipes varus the cutting of the tibialis anticus, extensor pollicis, and possibly of the extensor communis digitorum may be required. In cases of talipes cavus the operation of fasciaotomy or division of the strong longitudinal bands on the sole of the foot and tenotomy of the tibialis anticus may be necessary; while in severe cases of flat-foot it may be necessary to divide the peroneal muscles. Where the operation of fasciaotomy is performed it should be done subcutaneously and with great care. Some operators advise the open incision in case of tenotomy. The author sees no necessity for such an operation, because it is usually easy to find the tendon and cut it, making only the very slight incision required for the introduction of the tenotome, and thus allowing no infectious material to enter the wound; while with open incision there is not only the danger of infection, but always a very much larger cicatricial area, which may perhaps cause adhesions and prevent the action of the muscles. The operation of tenotomy is easily performed. Of course it should be done aseptically. The knife used is the ordinary tenotome, either sharp or blunt pointed as the surgeon may desire. What is known as a "valvular" incision is preferable because it adds another safeguard against the introduction of infection into the wound. When the tendon has been divided the foot is restored to the correct position and a little plug of gauze, wet in bichloride of mercury solution, is placed over the wound; then the foot is wrapped in plaster of Paris bandages which have been soaked in the bichloride solution. This renders the dressing perfectly antiseptic and it is seldom that any trouble follows the operation. The old method of leaving the foot in the deformed position until the wound has healed is without support to-day, because it is much more difficult afterwards to bring the foot to the correct position, while if corrected at the time of the operation plastic material fills in between the two ends of the divided tendon, making a continuous length so that when this plastic material becomes hardened the tendon has not diminished in strength, while the requisite new tissue for an addition in length has been gained. The plaster of Paris splint may be removed at the end of a week or ten days and by that time the external wound is usually found perfectly healed. While the foot may be sensitive for a few days the patient may be allowed to walk about on it without danger. The operation of fasciaotomy is more extensive. The child is laid on the table face downward; the foot is put on the stretch by an assistant, and the surgeon feels with his finger for the points of contracted tissue. The knife is introduced

with the flat side parallel with the longitudinal bands, and after being introduced is turned with the edge so that by a sawing motion the band is cut in two. When one band or fascia has been cut others spring into view, and it may require several punctures and quite extensive cutting in the sole of the foot in order to relieve the deformity. As a rule there is but slight hemorrhage, but occasionally through the abnormal distribution of some small artery the bleeding may be quite extensive. In cases where it cannot be stopped by pressure it may be necessary to make an open incision, find the artery and tie it. Occasionally where an artery has been wounded in the sole of the foot a traumatic aneurism has formed and requires operation at a later period. Operations of tenotomy and fasciaotomy may be only preparatory to the treatment which must be employed to restore the function of the foot, and this must consist of electricity, massage, application of heat, etc., as already mentioned.

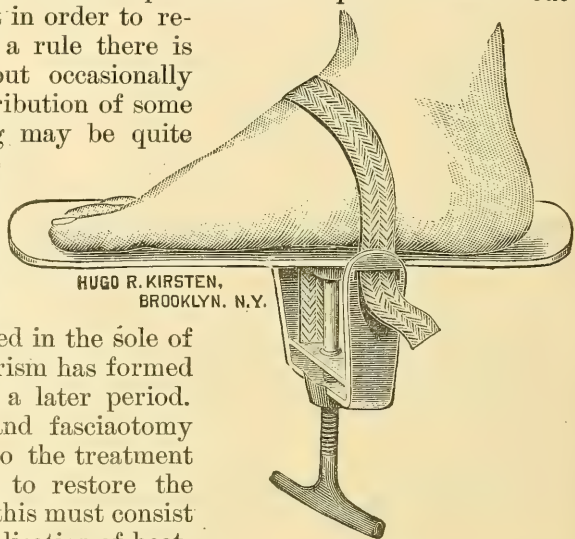


Fig. 396.

The Author's Apparatus for Bringing Down the Arch.

In severe cases the following measures are employed: The open incision, the use of extreme force, tarsal osteotomy and tarsal resection. The operation by open incision consists

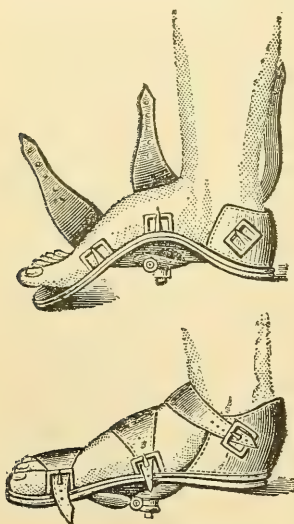


Fig. 397.

Apparatus for Bringing Down the Arch.

of a more extensive division of the fascia and of the soft parts of the foot than would be included under the term of "fasciaotomy," and instead of being sub-cutaneous the foot is cut across, dividing the soft structures thoroughly so that the resistance is overcome as much as possible. This open incision, which was first advocated by Phelps, is begun by dividing the skin along the inner side of the foot from the top of the malleolus low down on the inner side of the first metacarpal bone, the tibialis tendon is then cut across and the artery may be divided. The foot is brought into normal position and the wound packed with iodoform gauze and fixed in plaster of Paris bandage. It is sometimes very difficult, even with very extensive incisions, to relieve the deformity and a great deal of force may be required to restore the distorted foot to a correct position, but it should be brought as nearly to the normal as possible and allowed to heal by granulation. The operation should be done aseptically and the foot kept in position until the wound has healed. There is a great tendency for the cicatrix to contract and draw the foot around in a deformed posi-



tion again; this can be avoided by the use of plaster of Paris or leather splints, or by the use of one of the forms of club-foot shoes.

The use of extreme force is employed where it is inadvisable to perform the operation of tenotomy, and under an anesthetic instruments

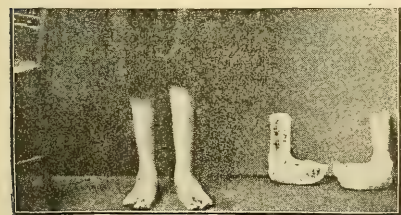
are used which are in the nature of powerful wrenches. These take strong hold of the foot and sufficient leverage is gained by the use of the apparatus so that the foot can be twisted around in the correct position. There are various forms of apparatus of this sort which are used, as Morton's club-foot stretcher; the lever correction apparatus, and Thomas' wrenches.

The object is to tear or stretch the contracted tissues to such an extent that the foot may be straightened.

The bandage should be carried above the knee and up the thigh, and the leg should be flexed at the knee to prevent rotation of the foot. In some cases these operations may be supplemented by tenotomy or fasciotomy. Successful cases are reported by Wolf, Bradford and Lovett and others.

**TARSAL OSTEOTOMY.** The methods employed in tarsal osteotomy have been grouped by Bradford and Lovett as follows:

Removal of the cuboid alone; removal of the astragalus alone; removal of the astragalus and cuboid and scaphoid; section of the neck of the astragalus; removal of the astragalus and the external malleolus; osteotomy of the lower end of the tibia and fibula; wedge-shaped resection of the tarsus. According to these authors the results from the first method have not been altogether satisfactory; the fourth may be said to be insufficient; and against the third and sixth may be urged that too much mutilation of the foot results. Authorities differ in the advocacy



**Fig. 399.**  
**Result After Phelps' Operation.—**  
**McKenzie.**

of the second and seventh methods.

The following description of the operation of excision of the tarsus in club-foot is given by Bradford and Lovett:

An Esmarch bandage is applied to the foot and an excision is made along the outer border from the middle of the os calcis to the middle of the fifth metatarsal bone. This is joined at right angles by another incision across the dorsum of the foot, the soft parts being reflected. The cuboid is first removed, then a wedge-shaped portion of the tarsus, of sufficient size to allow the foot to be brought into proper position without much



**Fig. 398.**  
**Showing Result in Phelps' Operation.**



force, is excised. The wedge of the bone may be removed with a chisel or sawed, should have its base of a width corresponding to that of a cuboid, and should be rather thicker above than at its lower surface. The operation should be performed with the strictest antiseptic precautions, after which the foot should be held in the corrected position and



Fig. 400.

Line of Incision and Position of Foot after Phelps' Operation.—McKenzie.



Fig. 401.

Position of Foot After Phelps' Operation, Showing Large Bursa on outer side of Foot.—McKenzie.

fixed by means of a plaster of Paris, bandage, or some other efficient form of fixative appliance. The authors named have used a splint made of strong iron wire, instead of using plaster of Paris, the foot being held in place by means of adhesive plaster. Inversion of the limb is prevented by winding plaster strips around the leg. This operation, although apparently one of great severity, is followed by good results. The foot may be restored to its correct position so that the patient instead of walking on the side of his foot is able to walk upon the sole. There are certain objections made to this operation, such as a certain amount of risk and the removal of all chance of restoration of the foot by orthopedic methods.

But these objections are fully met by

the fact that the operation would only be performed in cases where no other method could be employed, and it is perfectly justifiable to give the patient the benefit of the operation; even though it does involve a certain amount of risk the risk certainly is not very great, especially as compared with other surgical operations which may be performed for conditions much less distressing.

Osteotomy may be performed for the restoration of the foot where the astragalus has been deformed by the action of a long-continued pressure. Astragalus-osteotomy is described as follows by Bradford, the author of the operation.—“The procedure,” he says, “will not be found



Fig. 402.

Drawn from photograph before operation in boy of twelve. (Bradford.)

a difficult one.” It should be done with the foot stretched and manipulated into nearly as normal a position as possible. An incision through the skin is made from the top of the malleolus to the inner side of the head of the first metatarsal, which will be found in severe cases close to the malleolus. The

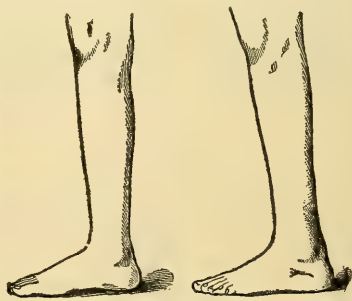


Fig. 403.

Photograph after operation in boy of twelve.—Osteotomy of neck of astragalus and os calcis. (Bradford.)

scaphoid will be seen before the astragalus is encountered if the deformity is great, and it will be first in reach of the knife in all cases.

If the foot is still further stretched, as the scaphoid begins to uncover the side of the astragalus and the neck of the astragalus is seen. A small osteotome is entered and placed upon the neck of the astragalus to the distal end and the neck of the astragalus divided, or nearly divided. The foot is then forcibly straightened, and the neck of the astragalus is chiseled and fractured. The result is similar to that in Macewen's operation for knock-knee, the distortion about the neck of the astragalus being removed. It is manifest that the line of section of the bone at the neck of the astragalus should be transverse to the axis of the bone, and at such a plane that when the equinus deformity is corrected the resulting gap at the section will not be greater than necessary. Strict asepsis is essential. The foot should be fixed in the corrected position. In many cases of operations for club-foot the after-treatment is quite as important as the operation in order to secure a permanent result. There is frequently a tendency toward return of the deformity from re-contraction of the tissues, and it is necessary to use some form of retentive apparatus for a considerable length of time, until this tendency has disappeared. Where there is a constant inclination of the foot to return to the position of varus after operation the club-foot shoe should be used. Later on a device which tends to throw the outside of the foot up may be applied. This may consist of a semi-circular piece of steel which is fastened to the outer side of the sole of the foot in such a manner that the patient, in walking, strikes this steel first and the foot is thrown outward. The importance of the use of electricity or other means to restore the nutrition of the limb must not be forgotten.

## CHAPTER XI. FLAT-FOOT.

**Etiology.**—Flat-foot is occasioned by depression of the bones of the arch of the foot. It is a mild form of talipes valgus. It is frequently an acquired condition and very common among men who stand during their work. In Ger-



Fig. 404. Medium Degree of Flat-foot.

many it is said that a large proportion of the waiters in restaurants are flat-footed. The reason given for this is not that it is on account of their occupation, but, on account of their exemption from military duty, because of their physical disability, a great many of them become waiters in restaurants. Frequently from paralysis of certain muscles, notably the tibialis anticus and the extensor longus pollicis or extensor primialis digitorum, and from weakness of

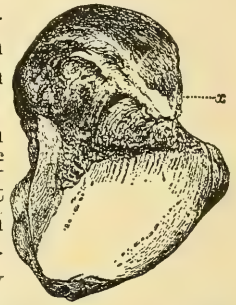


Fig. 405. The Astragalus in Flat-foot. x, Bony Wall.

the ligamentous structures which hold the bones in their proper position, the arch of the foot gives way and is pressed downward to the floor in walking. This not only gives rise to deformity, making the foot appear ugly in shape, but also occasions severe pain to the patient. The deformity consists not alone in the loss of the arch of the foot, with its natural and graceful contour, but also in a displacement of the astragalus downward and inward so that it projects from the inner side of the foot, giving an exceedingly ugly appearance. The displacement of the bones frequently causes severe pain to the patient in standing. In the correct position of the bones the articular surfaces are free from nervous or vascular structures, these being placed at the sides where pressure upon them is avoided; but when displacement takes place the edges are brought into apposition so that these sensitive structures are pinched between the sharp corners of the bone. This causes the severe pain that is felt when the patient is standing, and explains the relief which he receives when the foot is restored to its position, either by pressure with the hand or by standing on some substance which raises the arch. The pain is usually quite severe and is felt across the top of the foot, sometimes radiating downward toward the toes or underneath the foot. The projection of the astragalus is often mistaken for some abnormal growth and frequently treated as such, when by simply pressing the foot around into the correct position the deformity at once disappears.

**Treatment.**—In cases where the deformity is paralytic, or where it is due to the weakness of the muscles on the anterior portions of the leg, treatment by electricity and massage is of the greatest benefit. The



foot should be restored to its normal position and be kept so by some form of apparatus which can be placed within the shoe. Frequently children suffer from this condition, and in such cases the application of a steel spring

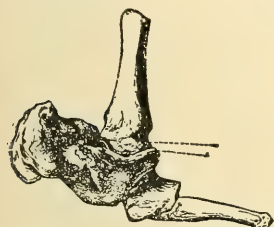


Fig. 406. Reflexed External Arch of Foot. a b, Nearthrosis Anens and Fibul. (After Lorenz.)

or a piece of cork to the inner side of the shoe may be all that is necessary for the raising of the arch. In some cases it is necessary to use a brace

which consists of two steel bars running up the inner and outer side of the leg, the

strap being attached to the outer side of the sole, running across it and up and out from the inner side of the shoe and fastened to the top of

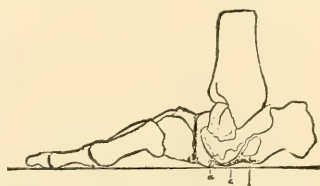


Fig. 407. Internal Aspect of Flat-foot. a, Tub. Nav., which forms a Fulcrum, and which is the deepest portion of the Internal Border of the Foot; c, Lig. calc.-nav. plant, forming an arch between its two points of insertion a and b. On account of the adduction-contraction of the middle portion of the foot, the metatarsus hal. appears shortened.

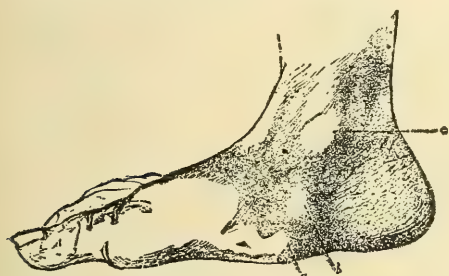
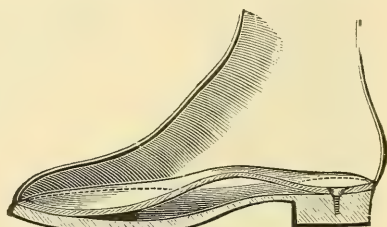


Fig 408. Severe Flat-foot.



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Fig. 409. Steel Support for Flat-foot.

the inner bar of the brace. By tightening this strap the arch of the foot may be raised to the necessary height to overcome the deformity.

## CHAPTER XII.

### ANKLE-JOINT DISEASE.

**General Considerations.**—The ankle joint is subject to the same form of tubercular disease as the knee or hip joint, and there is no especial difference as regards the pathological or etiological conditions, so that it is hardly necessary to go into a detailed account of the factors which enter into the causation or the pathology of the disease. A tubercular disease of the ankle-joint, however, is likely to involve a large amount of bony tissue, as the spongy portions of the tarsal bones, and so

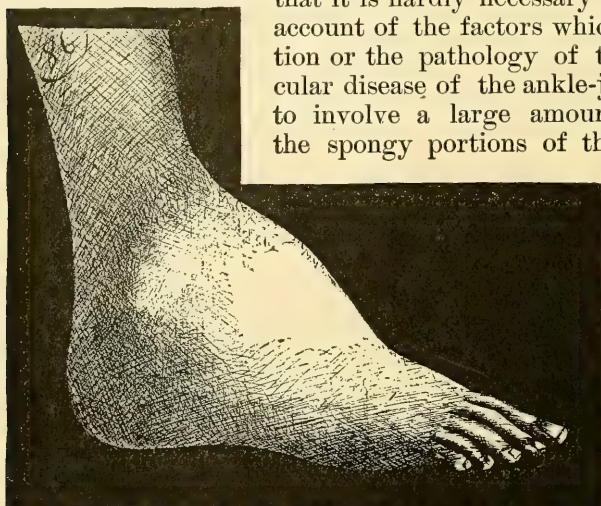


Fig. 410. Diseased Ankle.

many joints are involved between these small bones that healing may result in complete loss of function. When supuration sets in the disease may affect a large number of bones, and operative procedures which attempt the removal of the diseased bones may be so extensive

that many of the tarsal joints are completely removed, when, if healing can be induced, complete ankylosis of the joint will probably result. The general symptoms may be much the same in character as those of hip-joint and knee-joint disease, only perhaps less severe, and the general effects of the disease may be similar as regards the joint itself.

**Treatment.**—The treatment of tubercular ankle-joint disease is by methods similar to those employed in diseases of the other joints. It is easier to apply the retentive apparatus than it is in the case of the other joints, but more difficult to apply extension, on account of the difficulty of getting a proper hold on the foot. To immobilize the joint splints of plaster of Paris or felt or any other of the materials which are used ordinarily are easily applied, but extension may be best made by means of Sayre's apparatus. Of course the patient should not be allowed to bear his weight on his foot, and if he goes about it should be on crutches, with a high shoe on the opposite foot.

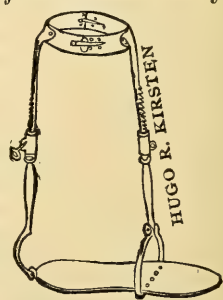


Fig. 411. Sayre's Extension Apparatus.

The operation of excision is done largely with a curette or the flushing gouge rather than with a chisel or knife or saw, and in all other cases

the diseased focus should be as thoroughly removed as possible. If an unopened abscess is present the same form of treatment as that indicated for the other joints may be employed, but the treatment of these cases is exceedingly tedious and extends over a considerable time. Frequently patients do not suffer from so great constitutional disturbance as they do in the disease of the other joints, but it is likely to be a long time before a cure is effected.

**MEDICATION.** Among the remedies that will be useful in ankle-joint disease *asafetida* will be found most helpful when the tissues are swollen and boggy and when caries has followed upon a syphilitic history. The bones of the joint soften and ulcerate, and external ulcerations that are deep and bluish form on an edematous base.

*Calcareo carbonica* and *calcareo phosphorica* will naturally be thought of and prescribed in the typical *calcareo* child, the former when rickets is pronounced, the latter when the bones only are affected, the general health remaining in a better state.

*Silicia* is called for in long continued suppuration of the ankle or other joints, and *hepar* and *mercurius vivus* will be indicated when suppuration threatens or when it is long continued, the discharge being ichorous or thin and flaky.

If tuberculosis is at the bottom of the trouble *arsenicum iodatum*, or other preparation of iodine, will be most helpful. Sulphur may also be demanded as a basic remedy in tuberculosis subjects.

Fluoric acid or *calcareo fluorica* will be required when the surfaces of the bones entering into the composition of the joint become nodular and roughened, even ragged, especially if syphilis is the cause of the disease of the joint.



## CHAPTER XIII.

### DISEASE OF ELBOW AND SHOULDER JOINTS.

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**General Considerations.**—The elbow-joint and shoulder-joint are also liable to tubercular disease and manifest the same general symptoms as in the diseases before mentioned, and the particularly marked symptom in all cases is the limitation of motion. In some cases of elbow-joint disease there may be slight flexion, with some swelling and bogginess about the joint, but with little pain. Abscess may form and even general tuberculosis finally result. If excision is resorted to it should be employed early, as the author has observed a late excision of the elbow-joint followed by reinfection, necessitating amputation of the thigh for disease of the knee-joint, and finally death from general tuberculosis. In another case where an apparently thorough excision was made of the elbow-joint the disease persisted, infection ensued, and an amputation at the shoulder-joint about a year afterward seems to have saved the patient.

**Treatment.**—Extension may be employed and much more easily than in the case of the lower limb. The application of cold and all the other remedial measures which have already been mentioned for treatment of tubercular abscesses may be employed. The excision of the shoulder-joint is likely to be accompanied by better results than in the case of the elbow-joint. After excision of the elbow-joint there is likely to be a flail-joint resulting, because it is impossible to reproduce in the joint the depressions of the condyles and process which exist in there normally. In the shoulder-joint, however, which is a ball and socket, the incision is easily made and the new head of the femur which is produced fits sufficiently well into the glenoid cavity so that the resulting joint is very serviceable, and there may be no special impairment of function. In cases of tubercular disease of the elbow- or shoulder-joints the author urges the prolonged application of cold. It is easily applied and easily kept in position and the patient can go about with little or no trouble.

In reviewing the conditions of the joints which have been passed over, and into which tuberculosis enters as such an active factor, it is impossible at present to lay down strict rules covering the treatment of these cases. In the early stages it must be more or less tentative and expectant; in all cases the limiting of function of the joint as far as possible is most important.

In many cases the disease seems to be simply a local condition which is easily suppressed; in others there is a grave constitutional affection and the local symptoms are simply the outburst of a smothered fire. It is probable that the most active antagonist of this disease is some form of iodine, and the best known preparation is that of iodoform. The use of extension and immobilization has only the effect of preventing functional hyperemia, but has otherwise no curative effect, or any antagonistic effect, upon the tubercular bacilli. Cold has an inhibitory effect and may

prevent their development sufficiently long to allow them to become so thoroughly encysted that unless some traumatism occurs there is no danger of general infection. All operative procedures are methods of last resort. When it is found that no other measure is of any use, then the attempt is made to remove entirely by one radical operation all the diseased tissue. In many cases these are successful, in others they are followed by apparent success but with re-infection, in the course of a couple of years; while in the third variety the operation seems to be of no use. Still, when it comes to the question of deciding whether the patient shall be allowed to go on to certain death unless an operation is performed it seems better and more humane to give him the benefit of the doubt and do the operation, rather than to make him face an inevitably fatal result.

**MEDICATION.** As in disease of the hip-joint, knee-joint and ankle-joint so also in disease of the elbow- and shoulder-joints the proper homeopathic remedy will be found of service in selected cases. The calcareas, iodine, silicia, fluoric acid, arsenicum, especially in combination with iodine, hepar, mercurius, and occasionally asafedida, nitric acid and aurum metallicum will be of unquestionable value. If rachitis is at the base of the disease the calcareas, fluoric acid, and, perhaps, silicia will be most beneficial. If syphilis is the predisposing cause aurum, nitric acid, kali jodatum, asafedida and perhaps mercurius will be required. Thuja is sometimes helpful, while sulphur will be demanded in typical sulphur cases with the symptoms of this drug. Too much reliance must not be placed upon medication, however, to the exclusion of up-building agents, fresh air, improved hygiene and proper surgical measures. On the other hand, it will not do to altogether neglect the proper constitutional remedies, since many cases of joint-disease are wholly due to constitutional dyscrasia which may be modified or altogether up-rooted by homeopathic medication.

## CHAPTER XIV.

### WEAK MUSCLES.

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**Frequency.**—Parents frequently wonder at the peculiar gait of their children. They notice that they toe in, that they have a shambling gait, and that all these symptoms increase if the child is tired. This they attribute to carelessness on the part of the child, and endeavor by discipline, urging, and constant admonition, to have him exert himself to overcome this apparent shiftlessness. But there are actual pathological conditions which enter into the production of these symptoms which are always the result of weakened muscles or of diminished nervous power. If the muscles of one side of the child's limb are normally strong and those on the other side are weak the result will be that the strong muscles, acting easily and normally, maintain their correct attitude under all conditions, while the weak muscles, which may be kept in line by the action of the will of the patient, soon tire and are overcome by the opposing strong muscles. A child is told to walk with his toes turned out. He does so as long as his attention is kept on it, but as soon as his attention is diverted the strong muscles involuntarily incline the limb to the abnormal position. In walking it may be observed that he goes with a leg slightly flexed, and this may continue through life. People are often observed who walk with an awkward gait and the same symptoms which are observed in childhood, as toeing-in. One leg is apparently shorter than the other, but on close observation it may be observed that in walking the subject does not fully extend the leg when he throws it forward; this is due to weakness of the muscles on the anterior portion of the thigh, and unless treated and the muscles evened-up this person will always have the awkward gait described.

Little attention has been paid to this subject, but within the past few years Dr. King and the author have been giving special attention to it and it is found that frequently the effect on the general tone and disposition of the patient is quite marked. In some cases where before the muscles were evened-up it was noted that the patient was morose, and easily tired, after the treatment by massage and electricity until the muscles were properly balanced there was complete change in the mental condition. This subject is one which should receive more attention at the hands of physicians, and in many cases where the mental condition has been attributed to a constitutional perversion, or where the awkward gait has been attributed to laziness on the part of the patient, it may be found that an actual pathological condition exists which has caused these symptoms.

**Treatment.**—The treatment should be active, the patient should receive such remedies as have a tendency to build up and strengthen the general system and he should not be kept closely confined to school. Massage and electricity should be applied, and the latter is probably the most active agent in the restoration of the muscles. It cannot be ap-



plied indiscriminately by everyone, and when it is applied it should be done by an expert, who understands the picking out, and differentiation and comparison of the various muscles from their motor points. He should also be thoroughly conversant with the method of treatment by means of the galvanic or faradic electricity. The chapter on electricity, by King, will give in detail the methods of treatment.

One of the most healthful exercises which can be employed is riding of the bicycle. The author is very much in favor of the use of this vehicle for children who require stimulation and exercise. It is healthful and invigorating, and it gives an exhilaration to the mind and body, it gives them an impetus to take exercise which they would not otherwise have, and in cases of lateral curvature, or in any condition where the weakness is due to a general lack of muscular tone, there is probably no means of general stimulation and invigoration better than this.

MEDICATION. But little will be expected of medication in weakened states of the muscles, yet remedies like *kali muriaticum*, *natrum muriaticum*, *kali phosphoricum*, *calcareo carbonica* and *calcareo phosphorica* act beneficially in restoring the functions of the body, whereby the constitutional state of the system is improved and muscle-building is better carried on. *Kali muriaticum* is especially recommended by those practicing the Schusslerian method, as having specific influence upon muscular structures. Supportive nourishment, massage, electricity, change of air, and moderate and appropriate exercises are, however, more likely to result curatively than medication without these. As stated, but little is to be expected of efforts at muscle making or strengthening through remedies.

## CHAPTER XV.

### HALLUX VALGUS, AND OTHER MINOR AFFECTIONS.

**Definition.**—In this condition the great toe is twisted outward, and it may be to such an extent that it either overlaps or is covered by the other toes.

As a result of this distortion the joint becomes very prominent and from the irritation of the skin, callosities, which are known as bunions,

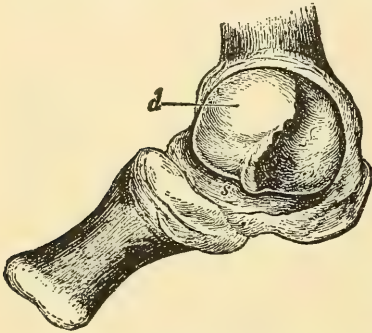


Fig. 412.

Hallux Valgus. Only the Surface, d, is in Contact with the Phalanx and Covered with Cartilage.

form over the joint. Also the head of the first metatarsal bone becomes much enlarged, and often sharp, spike-like growths of bone develop, which press against the inflamed skin and cause intense pain.



Fig. 413. Hallux Valgus in an Elderly Woman.

In some cases the bursa over the head of the bone inflames and suppurates and a fistulous opening results.

**Causes.**—Hallux valgus is usually found in patients beyond youthful age, but is occasionally found in young people as the result of wearing too short shoes, which they have outgrown. Pressure of a tight shoe over the joint may cause the joint to inflame, especially if the shoe is pointed and short. A long pointed shoe will cause no trouble providing



Fig. 414.

Position of the great Toe in Consequence of Faulty Pointed Shoes.



Figs. 415 and 416.

Proper Shape of Sole. (After V. Meyer.)

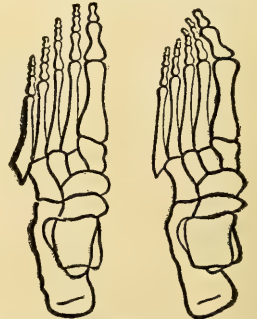


Fig. 417.

Position of Hallux Valgus in Comparison with the Bones of the Normal Foot.

the inner side of the shoe is straight. It is not necessary to have a shoe ugly in shape in order to have it comfortable or healthful for the foot. Rheumatism and gout are frequent causes.

The pain arising from hallux valgus is often most excruciating in character, and especially in warm or stormy weather, and the sufferer sometimes becomes almost desperate from the pain.

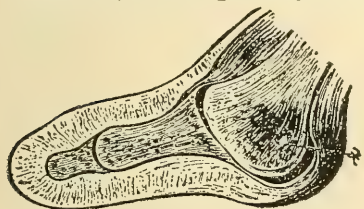


Fig. 418. Hallux Valgus (Transverse Section). x, Exostosis.

relief. The operation of resection of the head of the metatarsal bone restores the toe to its proper position. It is claimed by some authors

that it must be performed with caution, as in some cases the results have been bad. Some writers claim that only flat-footed patients should have the operation. In several cases in which the author has operated the results have been satisfactory. The operation should be performed under extreme aseptic precautions. A longitudinal incision is made through the integument down over the joint to the bone. The soft parts are dissected away and the head of the bone freed. It is then clipped off

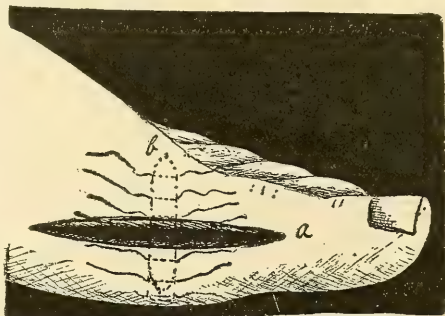


Fig. 419. Author's Operation for Hallux Valgus.

with a pair of bone forceps and all sharp points trimmed away. The wound is carefully closed, the joint capsule being stitched up first with buried sheep-gut sutures. In order to bring the toe into correct position and hold it there the writer shortens the capsule by stitching crosswise, thus bringing the base in direct opposition with the end of the metatarsal bone: a, shows longitudinal incision through capsule, b, with dotted line, showing same stretched crosswise in order to shorten outer side of capsule.

The external opening may be stitched longitudinally and before it is done the hardened skin should be removed. A plaster of Paris cast is applied to hold the toe and is retained in position about ten days. The patient should not be allowed to put the foot down until healing is complete.

**Hammer Toes.**—Hammer toe is the term applied when the first phalanx is extended and the others flexed. It occurs most frequently in the second toe. It may be due to too short or narrow shoes, and sometimes it is difficult to assign a cause, while in many cases it is probably of paralytic origin.



Fig. 420. Hammer Toes.

**Treatment.**—A sandal which holds the toes in position may be used. Digitated stockings, electricity and massage may help.

In some cases tenotomy may be required to bring the toe into proper position.

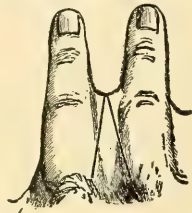
**Painful Affection of the Foot.**—This is sometimes called Morton's neuralgia, and occurs most frequently in young adults.



It may be caused by squeezing the foot, or by a slight twist, and sometimes comes from no assignable cause. The pain may be very severe and paroxysmal and it may be almost impossible for the patient to endure it. It occurs at about the junction of the heads of the fourth and fifth metatarsal bones and may extend up the limb.



**Fig. 421.**  
Dorsal Flap brought through between fingers and stretched on the palmar side. Also wound closed on opposite side of fingers.—Agnew.



**Fig. 422.**  
Form of Incision for Webbed Fingers.—Agnew.

It is caused by the pinching of the interosseous nerve between the heads of these bones. Even, snug compression of the foot, and rest, is the most convenient remedy, but in severe cases the head of the fourth metatarsal bone may be excised. Rhus tox., ledum, hypericum, arnica, belladonna, ruta graveolens, colchicum, magnesium phosphoricum and other internal neuralgic, rheumatic and anti-spasmodic remedies are occasionally very helpful in this

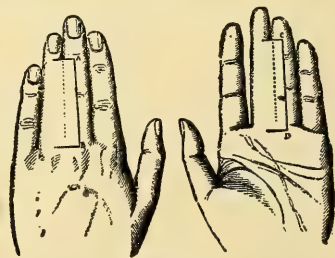
condition, the most painful disease of the foot.

**Web Fingers.**—When two adjoining fingers are united it is a congenital condition of webbed fingers.

It can be relieved only by an operation, and the difficulty in the operation lies in preventing the web from growing again from the angle, and in covering the raw surfaces after separating the fingers. The devices shown in the cuts explain themselves. The author has been able, by applying a Theirsch's graft to cover the raw surface satisfactorily, and thinks this in connection with Agnew's device for covering the apex of the incision superior to Didot's operation.



**Fig. 423.**  
Didot's Operation for Syndactylism, Represented in Cross Section.—Bradford and Lovett



**Fig. 424.**  
Didot's Operation for Syndactylism.—Bradford and Lovett.

**Toeing-In.**—Toeing-in may be caused by weakening of the external rotators of the thigh, and may exist to such a degree that it is impossible for the patient to turn his toes out.

Electricity is probably the best remedy, and the assistance of an apparatus may be required. It should be borne in mind that no apparatus is of use in inverting or everting the foot unless it has a pelvic band from which to obtain its leverage, unless the toes are forced apart by some of the clumsy arrangements occasionally but not wisely resorted to. Doyle's spring rotator is probably the best form of apparatus for this condition.

## CHAPTER XVI.

# ELECTRICITY IN ORTHOPEDIC SURGERY.

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**Applicability.**—Any of the different phases of action of the electrical current may be of interest to the orthopedist, but those which are most directly involved in his work are, first, the action of the galvanic current in absorbing inflammatory effusions or deposits in nerve sheaths and joints; second, the action of either galvanism or faradism in stimulating nerve tissue to increase the conductivity of the nerve, when such conductivity has become obstructed from any cause, by an effusion within its sheath, causing pressure upon the fibers, or when due to cicatricial tissue, the result of injury or an operation; and, third, the power of the current to increase nutrition and to develop muscular tissue.

Regarding the first action of the current under consideration, the power of galvanism to produce absorption of inflammatory effusions or deposits, it is best not to use electricity, either galvanism or faradism, during the active stage of inflammation. Some have claimed marked success with the faradic current of tension. The author must admit, however, that he has never derived permanent benefit from treating any acute inflammatory affection with this current. It is admitted by its advocates that it cannot be demonstrated that the faradic current of tension contracts the blood vessels or in any way relieves the congestion permanently, or, for that matter, temporarily, but that it produces a temporary anesthesia which, at best, is of short duration.

It is after the acute symptoms have passed away that the action of the galvanic current is needed to break up the deposit into its several constituents, the atoms of which are rearranged to form new molecules and thus become absorbed. The catalytic action of that current, no matter what that may be—whether it be as set forth in Remak's theory as to its oxygen-producing power, or its action on the red blood corpuscles—is also needed to increase the nutrition and repair the waste the inflammation has caused. There is also needed the stimulating effect on the shattered nerve filaments to bring them back to their normal action and thus relieve the pain. Faradism and Franklinism may possess some of these qualities, but they are lacking to a degree in all, and in some of the most important their action is nil.

**Technique.**—The technique in the treatment of these cases is important. To simply pass a current through an affected joint, irrespective of the strength and manner of its passage, is not sufficient. As the knee is the joint most commonly attacked with inflammation it will be well to take it to illustrate the treatment. If it is very sore and tender it is best to pass a current from above to below the joint. This is done by placing the large, flat, positive electrode about six to eight inches above the knee, and, with a flat hand electrode, begin six or eight inches below and give labile applications up over the knee, such treatment to continue for from

eight to ten minutes. These treatments may be given daily or every other day, using five to ten milliamperes.

It will be found that the excessive soreness and tenderness will decrease rapidly under this treatment, and after a few weeks, at most, treatment can be given through the joint. For this it is necessary to use large electrodes, so that quite a large quantity may be passed, and also that it may be distributed through the joint. It is necessary that the electrodes should be thoroughly wet in hot water and applied to the knee a minute before the current is turned on, so that the skin will become moistened, allowing the current to pass smoothly and evenly through the joint. To keep the electrodes warm a large bath towel should be passed around them. It is best to begin the first treatment with about eight or ten milliamperes. The current should be given stable, i. e., held stationary for ten minutes, then labile applications be given for a few minutes over the joint, using the negative electrode, the positive being placed on the thigh above.

The author does not believe there has ever been appreciated the effect of treatment on the tissues immediately surrounding the diseased area. It is essential that the blood vessels be acted upon through the vaso-motor nerves at these points, so as to equalize the circulation and increase the nutrition to the parts.

When the conditions are reached which involve the second consideration, the stimulation of nerve tissue, or the increase of the conductivity of the nerve, the surgeon immediately becomes involved with electro-diagnosis, for it is most important in the treatment of these cases—not only electrical, but from every point of view—that the nature of the lesion should be understood.

With the broad field of electro-diagnosis the author has nothing to do, except to describe those abnormal reactions which, when taken collectively, constitute what is known as the reaction of degeneration.

**Changes.**—The abnormal changes in the reaction of muscles and nerves are: First, quantitative, and, second, qualitative.

**QUANTITATIVE CHANGES.** These consist simply in an increase or diminution of the electrical excitability of motor nerves or muscles. An increase of excitability is made known by the nerve or muscle reacting to a current of less strength than it will in the normal state, or when with the same strength of current the contractions are much stronger.

The irritability is diminished when a current of much greater strength is required to cause contraction than is required in health, or when, with the same strength of current, the contractions are much weaker. In quantitative increase or decrease of excitability both nerves and muscles react in the same manner as in health; that is, the muscles contract with a quick jerk, as in health.

The same laws that govern the reaction in health apply here also; that is, cathodal closure produces contraction with the weaker current, and anodal closure and anodal opening follow in the order in which they are given.

**QUALITATIVE CHANGES.** First, in the manner of contraction. Instead of the short, jerky contraction, as in health, it is long and drawn out; this is called a “modal” change. Second, the normal law of reaction to the galvanic current is changed; instead of cathodal closure producing



contraction with the weakest current anodal closure may do so, or the two may produce equal contraction with the same strength of current; or it may be that cathodal closure still leads, but the difference between them is less—instead of its being six milliamperes it may be only two or three milliamperes.

In some cases anodal opening may produce contractions before anodal closure. This is known as a “serial” change.

As the reaction of the nerves and muscles in reaction of degeneration differs, it is necessary to consider them separately.

**CHANGES IN REACTION OF NERVES.** The change in the reaction of nerves is a quantitative diminution to both galvanic and faradic currents alike. This decrease is either rapid or slow, according to the acute or chronic character of the disease. In an acute disease, such as infantile paralysis, or in a severe traumatic lesion of a peripheral nerve, there is a rapid decrease in the electrical excitability from the first, which may become completely lost in one or two weeks; while with a chronic or sub-acute affection it may be months or years before it is lost.

The period during which a nerve remains unexcitable varies with the nature and extent of the lesion which causes it. There are rarely any qualitative changes in the reaction of the nerves, but a modal change may be observed—that is, the contraction instead of being quick and jerky may be long and drawn out, or feeble.

**CHANGES IN REACTION OF MUSCLES.** With the muscles there are more characteristic phenomena. When a faradic current is applied direct to a healthy muscle that muscle is made to contract by the stimulation of the intra-muscular nerve fibres—the muscular fibres not being stimulated by currents of such short duration as compose the faradic current. It is, therefore, evident that the faradic current follows exactly the same course when applied to the muscle as it does when applied to the nerve. It has been shown that as the nerve degenerates it gradually loses its excitability to both galvanic and faradic currents, and as the intra-muscular nerve fibres degenerate along with the trunk of the nerve the faradic current will lose its exciting power when applied to one the same as to the other; but as a nerve begins to degenerate at the point of injury and goes toward the periphery it follows that the intra-muscular nerve fibres will be the last to degenerate, and, consequently, they lose their faradic irritability somewhat later than does the nerve, the difference varying with the character of the disease—being slight in acute, but longer in chronic diseases. Muscular fibres are capable of being stimulated with the galvanic current irrespective of the nerve which supplies them, and the changes of reaction in reaction of degeneration are highly characteristic.

The changes are, first, quantitative, which differs in acute and chronic affections. With the former there is at first a slight diminution in the excitability; but this is soon changed to an increase of excitability, and may even become so marked that only two or three m. a. will be needed to cause contractions that require six or eight in health, or, if the disease is unilateral, on the healthy side. This over-excitability may persist for several weeks, when it gradually returns to normal, or below normal and, in incurable cases, when the connection has been severed the excitability will be lost. With chronic affections there is a gradual diminution from the first. Second, qualitative changes, which consist,

first, of a modal change, and should be carefully looked for, as it is often the only indication in slight affections that reaction of regeneration is present. The serial changes in reaction of degeneration are the most characteristic of any.

The questions naturally arise, to what pathological condition does reaction of degeneration correspond, and to what alteration in nerves and muscular tissue is it due? Without going into detail of the various steps of our knowledge on these points, it may be said that it is due to a degenerative atrophy, which, in turn, is due to a stoppage of the peculiar influences of the gray matter (bulbous nuclei, anterior horn of the cord) upon the nerves and muscles. It therefore follows that these centres are the seat of the disease or the channels carrying their influence to the muscles, which are the motor nerves.

According to the latest research—says De Watteville—section of a motor nerve is rapidly followed by coagulation of the medullary sheath, softening of the axis cylinder and the breaking up of both, which eventually become reduced to an homogeneous mass of protoplasmic material, filling the sheath of Schwann. The axis cylinder does not survive, as was formerly believed, except when the nerve injury has been very slight. The neurolemma does not remain passive, but proliferates, and a cirrhotic condition of the nerve ensues. The intimate processes connected with the regeneration of nerve fibres have not yet been elucidated.

Now, when the relation of the different pathological changes to the electrical reactions is traced out, it is thought that the increase of muscular excitability to the galvanic current corresponds to the cirrhotic stage of the nerve; the loss of the muscular excitability to the faradic current, as has been stated, to the degeneration of the intra-muscular nerve fibres, and that the loss of galvano-muscular contraction indicates complete degeneration of muscular fibre. There is no use of attempting to restore a nerve after this has occurred.

When there is a simple quantitative decrease in the electrical excitability without the phenomena which indicate reaction of degeneration, the simple stimulation of the motor points of the nerves and muscles, as given later, is all that is required, but with reaction of degeneration the treatment should be directed, first, to absorb the deposit, if there be any, at the lesion of the nerve, by passing a current through it, and second, to increase the nerve current, to overcome any obstruction or resistance in its conductive path. This is best accomplished by placing the positive pole over the spine where the nerve is given off and the negative below the obstruction, and passing a strong current down the nerve. A few interruptions may be made. The strength of current employed should be about ten milliamperes and is allowed to pass for eight or ten minutes.

This treatment is to be given in the non-inflammatory types of disease, or after the acute symptoms have passed away, if of inflammatory origin, or after the wound has healed, if traumatic, and in those cases where the nerve has been severed, necessitating an operation to unite it, after the external wound has healed.

**Action and Stimulation.**—Undoubtedly the most important action the electric current offers the orthopedist is its power to stimulate the



nutrition and consequently to increase the strength of muscles. This action may be summed up in a few short paragraphs.

First. When the reactions are normal and a weak current is passed, without producing contraction of the muscles, the galvanic and faradic currents have equal power of development.

Second. When stronger currents are employed, with normal reactions, and contractions are produced, the galvanic slightly leads the faradic current in its power to strengthen the muscles.

Third. When there is a quantitative decrease in reaction the galvanic is superior to the faradic just in proportion to the change in reaction.

Fourth. When reaction of degeneration is present to such a degree that faradic contractions are lost that current has no power to stimulate muscles, while the galvanic has, and this power of the galvanic current is not due entirely to its power to produce contractions of the muscles, as it is capable of stimulating them without producing any contractions, but to a less degree.

Fifth. Strong muscles with normal reaction increase in strength more rapidly under the influence of electricity, either faradism or galvanism, than do weaker muscles.

Now, the lessons learned from this are:

First. In using weak currents when reactions are normal either the galvanic or faradic may be employed.

Second. When strong currents are used to produce contractions the galvanic is slightly superior, but either may be used.

Third. When reactions are changed either simple quantitative decrease or the reaction of degeneration is present and galvanism should always be used.

Fourth. When possible, contractions of the weaker muscles should always be produced, as the stimulating power of the current is much greater than when there are no contractions.

Fifth. When strong muscles overcome their weaker antagonistic opposites and thus produce deformity, by pulling out of the normal position any part of the body, care should be exercised to treat the weaker muscle or muscles separately and not the whole limb, as the stronger the muscle the more rapidly does it gain under electric stimulation, and, consequently, if all were treated alike, the deformity would be increased rather than decreased.

The continuous flow of an electric current does not produce contraction of a muscle. It is only the change of density of the current, such as a sudden interruption of its continuous flow, which produces contractions. The more sudden the change the greater the contraction. As the faradic current is made up of a series of interruptions (the current being interrupted with every swing of the vibrator) it, of course, produces contractions all the time the current is passing, providing the current be of sufficient strength. With galvanism it is necessary to interrupt the current for every contraction produced. This is best accomplished by using a handle which contains an interrupter that can be freely worked with the thumb or finger. The indifferent electrode should be of good size—say of three or four inches in circumference and placed at a point nearer the spine than the weakened muscles, generally over the part of the



spine which gives origin to the nerve which supplies them. The active electrode should be small. When it is applied to the muscle the ordinary two-inch electrodes which come with every battery may be used, but when applied to the motor nerves a smaller electrode is better. The set known as Erb's nerve electrodes are, perhaps, the best in the market. The active electrode is applied over all of the motor points which, by stimulation, will produce contractions of the weakened muscles. The negative pole should be attached to the active electrode, as it produces stronger contractions; but in those cases where reaction of degeneration is present to such a degree that the positive produces stronger contractions it should be used. Care should be exercised not to give treatments too soon after such inflammatory diseases as anterior poliomyelitis, as the strain put on the weakened muscles at this time might do damage. Never produce contractions too continuously at the same sitting. If the contractions grow less forcible after a few interruptions it should be discontinued. It is well where the muscles are very weak to produce a few contractions of one, then go to other points and finally return to the original point, thus giving the muscle time to rest. When a contracted fascia produces the deformity the fascia must first be cut, for it will be impossible to develop a muscle sufficiently strong to overcome this contraction. If a strong antagonistic muscle is not so much contracted that, by the use of the interrupted galvanic current, the deformity can be reduced after a few contractions and held there for any length of time, it is neither necessary to cut the tendon of the contracted muscle nor to wear a brace, as electricity alone will do all that is desired. If, however, the interrupted current will not quite reduce the deformity, but it can be easily reduced by the hand, a well-fitted brace will greatly facilitate the treatment.

The indications for tenotomy have already been given, and it needs no further consideration here. It is possible at times to reduce a very marked deformity by the use of the current alone; but if there is a constant strain on the muscles treated, by a contracted fascia or muscle working in opposition to it, it is liable to grow weak again and the deformity return.

**Classification.**—In order to facilitate the description of the different classes of diseases which come to the orthopedic surgeon the subject will be divided into three general classes: first, those due to peripheral causes; second, functional disturbances, and, third, congenital defects in the proper muscular balance.

With the first class (lesions of the peripheral nerves) are included those diseases which follow various forms of neuritis, either idiopathic or traumatic. After the acute symptoms have passed away and left muscles paralyzed or weakened, their local stimulation is indicated and the result will be very gratifying. In those cases where the neuritis has left deposits or other changes within the nerve treatment should be given to remedy it, but along with this muscular stimulation should also be given. Most excellent results are seen following local stimulation of muscles when the limb has been paralyzed from injury of a nerve by a fracture; and after the nerve had apparently healed, the muscles remaining inactive. The improvement in these cases is so rapid at times with muscular stimulation alone that it is easily manifest after each application.

What is referred to as functional paralysis or weakness of muscles are

those cases which follow synovitis, rheumatism, etc. The surgeon can understand how some of these may be due to an extension of the inflammation to the nerves, and, consequently, come under the second class; but, no matter which, the treatment, so far as building up the muscles is concerned, is the same. In the first place the joints should be treated according to the rules laid down in the first part of this chapter to relieve soreness and remove the deposits; then each muscle which has become weakened should be stimulated. The same is true where the wearing of a brace or splint has caused an atrophy and weakness of the muscles. Lateral curvatures come under this class of functional disorders, and here electricity will be found to be of the greatest benefit. The muscles to be stimulated are the erector spinæ, trapezius and latissimus dorsi.

The third group, congenital defects in the proper balancing of muscles, is a very important one.

There is a class of cases which come to the orthopedic surgeon, mostly children, which may have a peculiarity in their walk, or twist in one foot or leg, or a crooked manner of holding the head. Any part of the body, in fact, may be found to be slightly deformed. If close examination into the cause of this deformity is made it will be found that it is due to a lack of strength of a muscle or group of muscles, and these being unable to cope with the muscle or muscles placed in opposition to them, the deformity results. The history of these cases will not give the cause for the existing condition. Perhaps the patient has grown to manhood or womanhood before it has been thought of sufficient importance to be treated. If a careful electrical test be made it will nearly always demonstrate a quantitative decrease to both currents, as compared with the healthy side—more marked as a rule when the nerve rather than the muscle is stimulated. It may be possible that in a small proportion of cases this quantitative decrease is not noticeable on first testing; but, if a defective muscle is treated and the corresponding muscle on the other side of the body, is treated in the same manner for a week or two and another test be made, the difference in the quantitative reaction will be more noticeable. Now, when there is muscular weakness of one group of muscles and not of others there is a certain amount of deformity, varying with the location and severity of the weakened muscles. The different forms of talipes are simply exaggerated forms of this congenital deficiency. After the foot is placed in a brace and the tendons and fascia are cut, if necessary, the greatest benefit will be produced by treating the defective muscles with electricity.

All these cases can be readily relieved by going over the weakened muscles separately, and carefully stimulating them to such a degree that the deformity is entirely removed.

## SECTION XIII.

# SURGERY OF THE VASCULAR SYSTEM.

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## CHAPTER I.

### THE HEART AND PERICARDIUM.

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**Diseases of the Heart and Pericardium.**—The heart, though performing a purely mechanical function, has, for a very manifest reason, not been a field for much surgical interference. Its valves have often been clogged but no surgeon has undertaken to put them in order. The interior of the heart is “a holy of holies” that man has so far not dared to enter. Someone has boldly suggested tapping the right auricle in over-distention due to acute pulmonary congestion; but if abstraction of blood were necessary venesection would accomplish the same result in a much less formidable way. The latter operation has become antiquated and paracentesis auriculi is not likely to become popular.

The pericardium presents a safe field for paracentesis, or, if need be, incision, irrigation and drainage. Hydrops-pericardii sometimes results from idiopathic or traumatic pericarditis and sometimes is part of a general dropsy. When the result of local inflammation the fluid is generally absorbed, but not always; it occasionally increases in amount till it materially impairs the action of the heart and lungs.

Its subjective symptoms are precordial oppression, syncope, dyspnea, and, perhaps, aphonia, or difficulty in swallowing. Pain, from inflammation or pressure, is common, but variable and not diagnostic. On percussion flatness is found over an enlarged area; if a large effusion has existed for a considerable length of time bulging of the thoracic wall may be observed. On auscultation of the heart its sounds have a muffled, far-away character that is distinctive, those of the apex being higher than normal and considerably above the base of the distended pericardium. The pulse is weak.

**ASPIRATION.** When the effusion is excessive and mechanical difficulty caused by it is wearing out the patient aspiration may be slowly and cautiously done. For paracentesis pericardii a small trocar and canula are preferable to the ordinary aspirator needle. Puncture should be made two inches to the left of the sternum in the fifth intercostal space and suction applied if need be. Puncture with the trocar is rendered easier if a minute incision of the skin be previously made. The location of the internal mammary vessels should always be kept in mind. The abstraction of fluid should be slowly done, for sudden removal of pressure may cause syncope. Thorough asepsis must be maintained.



**INCISION AND DRAINAGE.** Incision and drainage of the pericardium are called for when the cavity contains pus. The opening may be made in the same place and a rib resected.

**Injuries of the Heart and Pericardium.—RUPTURE.** A few cases of rupture of the heart have been reported. Abscess within the walls or some other degenerative process has been the predisposing cause, emotional excitement or sudden exertion the exciting cause. Hearts literally broken may be of interest to the pathologist but offer no field for the surgeon.

**WOUNDS.** Wounds of the heart are frequently the result of stabbing and gun-shot wounds. Many are immediately fatal, some after a few days' time, and some are recoverable. The interlacing of the fibres of the heart is such that a small penetrating wound may not bleed much. Efforts have been made to sew up small stab wounds that were not sufficient to cause immediate death but kept leaking a little. Results have not been encouraging.

*Treatment.* The treatment of wounds of the heart and pericardium should be absolute rest in the horizontal position with warm applications to the extremities to help maintain proper temperature. Aconite should not be given during the depression of shock or when disposition to syncope is present, but after reaction has occurred and inflammation is threatened.

If infection has been carried into the pericardium and suppurative inflammation occur, in addition to incision and free drainage, hepar sulphur may be given. As good nutrition as possible should be supplied and stimulants administered at times. Complete obliteration of the pericardial sac by adhesion has been found post-mortem.

## CHAPTER II.

# DISEASES OF THE LYMPHATIC SYSTEM.

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**Lymphangitis.**—In structure and function there is great similarity between the lymphatics and veins. The direction of circulation, from the periphery to the center, is the same and both have valves; but while in the venous system there is a continual increase in calibre and unobstructed flow toward the heart, in the lymphatic system repeated infiltration of fluid is accomplished in the lymphatic glands. As each vessel approaches a gland it divides into a number of smaller ones, which as they penetrate the meshes of the gland lose all but their endothelial coat and become reduced to a capillary size. As a consequence the glands offer at least a temporary barrier to the spread of disease-germs or products. That the lymphatics have their origin in more open spaces that are favorable to absorption of irritant or septic matters than is the case with the veins is doubtless the reason for the more frequent inflammation of the former.

Lymphangitis is often caused by infected wounds, and sometimes occurs idiopathically in connection with inflammation of other tissues or alone. It is more common in acute or sub-acute forms but may be chronic, especially in persons with tuberculous or syphilitic cachexia. All the layers of the walls are involved in inflammation and the neighboring connective tissue is infiltrated. In acute inflammation local pain and irritation are soon felt and swelling is noticed. In a day or so the superficial vessels appear as red, slightly elevated lines, generally tender to touch and running toward the nearest lymphatic glands, which also become swollen and painful. Something like a chill is experienced with the onset of general fever, which, with local symptoms, varies in intensity. Most cases do not develop to the extent of danger to life, but some do. In such cases nausea, vomiting, delirium, and high temperature sometimes occur; again, a lethal depression creeps on without violent symptoms. Inflammation of lymphatics may be confounded with phlebitis, but as both require about the same treatment and often coexist the differential diagnosis is not important. Involvement of glands is characteristic of lymphangitis. In phlebitis if red lines are seen they will be broader and upon palpation the swollen and indurated veins will be felt much larger than lymphatics ever become. The location of the vessels will be a further guide. Edema beyond the site of inflammation is much greater in phlebitis. In erysipelas and dermatitis discoloration is more diffuse, and the inflammation is generally confined to the surface, is more circumscribed, and does not conform to the course of vessels.

Moderate, acute lymphangitis in persons of good vitality tends toward recovery by resolution in from a few days to two weeks' time; in weak or debilitated persons one or more foci of suppuration may form and recovery be longer delayed.

The pathological changes vary from a swelling and protuberance of the endothelial cells to their desquamation and a necrosis of vessel-wall

with formation of abscess. When the process terminates by resolution the swelling of cells subsides, or the denuded endothelium is replaced, the channel of the vessel is restored, and the tumefaction of connective tissue disappears by absorption. After destruction of vessel and surrounding tissue by abscess, obliteration occurs and the lymph must find other channels. The outcome in any case depends on the virulence of the sepsis and the patient's powers of resistance.

**TREATMENT.** Local treatment is of great service. If a septic wound exists from which the poison is being continually absorbed it should receive thorough antiseptic cleansing, and the whole inflamed area be put in a moist antiseptic dressing; i. e., absorbent cotton, or several layers of gauze moistened in a mercurial or weak carbolic acid solution, covered by rubber tissue and held in place by a roller. If in an extremity it should be kept a little elevated. If abscesses form they should be opened, drained, and the moist dressing continued. After resolution is well under way massage will promote it. Internally belladonna, arsenicum, apis, lachesis, bufo or silicia may be of service.

In chronic lymphangitis depending on constitutional dyscrasiæ medicinal and dietetic treatment must be the main dependences.

**Associated Conditions.**—Fibrous hyperplasia and induration of the vessel and surrounding tissue often cause occlusion of the vessels, as may cicatricial contraction, pressure from tumors, etc. Obstruction of a few vessels, while others are pervious, may not cause any noticeable trouble; but if the efflux of lymph is entirely prevented distention and gradual dilatation of lymphatics result, forming what is termed lymphangiectasis. This affection may sometimes develop from repeated attacks of local hyperemia or inflammation and without any ascertainable obstruction of lymphatics.

**Elephantiasis.**—This is an hypertrophy of the skin and sub-cutaneous tissue, supposed to result from occlusion and inflammation of lymphatics, caused by parasites.

**Macroglossia and Macrocheilia.**—These are peculiar hypertrophies of the tongue and lips due essentially to dilatation of the lymphatics. They admit of excision.

**Hydromata.**—These have their locale in the neck, beneath the occiput, consist of distended lymph-caverns, and are usually congenital.

**Rupture.**—Rupture of lymphatics is occasionally followed by effusion into some pre-existing cavity. Escape of chyle from the thoracic duct may cause chylous hydro-thorax or chylous ascites.



### CHAPTER III.

## DISEASES OF THE VEINS.

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**Function of the Veins.**—Life has been spoken of as “a struggle against gravity.” In that struggle the veins below the heart have the brunt of the battle—an uphill fight. After the arteries have carried the blood downward it is the duty of the veins to carry it up again during all the hours the body is in the erect position. Their walls, though thin, are strong and medium-sized vessels have valves that distribute the strain; yet hydrostatic pressure, acting two-thirds of the time year after year, causes them to gradually yield, so that few people pass through life without suffering lesions of the veins. Were it possible to maintain full tone of the venous system perpetual youth might become something more than a dream; but it constitutes the weak point in the human anatomy. It is largely the pressure in the veins that makes us feel tired; there is no inflammation or disease in the lower part of the body in which their weakness does not play an important part, and they are subject to their own diseases as well.

**Varix.**—Varix is a dilatation with loss of elasticity and deterioration of the walls, producing a knotted, tortuous enlargement and deformity of the vessels. The dilatation renders the valves ineffective and opens the way for the full force of downward pressure, the direct exciting cause of the disease. Pressure upon the veins by the gravid uterus, by tumors, or from any other source, is another direct cause. Impaired vaso-motor power, resulting from almost any debilitating cause, except wasting diseases, predisposes to this lesion. Poor nutrition, arduous occupations, syphilis, typhoid fever and post-diphtheritic paralysis in adults are frequent weakening causes. That consumption and allied diseases do not more dispose to it is doubtless due to the anemia and the inactive habits of their victims. Confinement in bed from any disease or injury is attended by rapid atrophy of venous walls in the lower extremities. Swelling of the limbs from vascular weakness is a common experience on getting up from such confinement. Over-straining of the veins at such time may cause dilatation that will become permanent. Many old indolent ulcers, commonly called “fever sores,” from their development after fevers, are an ever present evidence of this indiscretion. Weakened veins may with care be restored to proper strength and tone; without it they may be ruined.

Some veins are at a mechanical disadvantage and consequently more liable to dilatation; the portal and hemorrhoidal have no valves, and the lower hemorrhoidal lack the support of abdominal pressure given to vessels within, hence are particularly liable to become varicose; the spermatic of the left side are particularly pressed upon by the sigmoid flexure and contents, and varicocele is common; the superficial veins of the leg lack the support of the fascia lata given to the deeper veins, and, the hydrostatic pressure being great, they become varicose most frequently of all.

Varix is not apt to occur in parts above the heart except from pressure of cancerous or other new growths. Papular and eczematous eruptions and ulceration of the skin are frequently caused by varicose veins. The venous walls are often thinned in places, but are more generally thickened, mostly by hyperplasia of connective tissue; in the pouches of dilatation the blood often coagulates and phleboliths occasionally form.

**TREATMENT.** The treatment is palliative or radical. Reduction of vascular strain, by change of occupation or habits, and artificial support are the main palliatives. A woven elastic bandage, a flannel or cotton roller, carefully applied on or before rising and removed on retiring, will afford great relief to the heavy aching pain and will sometimes help the skin lesions to heal. Elastic stockings, anklets, etc., do good service while they fit. Any artificial support that does not fit properly and that causes constriction does more harm than good.

Arsenicum, hamamelis, pulsatilla, rhus and sulphur sometimes mitigate the pain or cause the skin lesions to heal, but their effect in causing diminution of sub-cutaneous varicosities is inappreciable. Hamamelis is a very satisfactory local application. Radical cure in the case of a few superficial veins may be made by multiple ligation, done in such a manner as to eliminate the desired vessels from the circulation. Anesthesia may be produced by cocaine, and buried ligatures of sheep-gut or other animal substance may be employed, careful asepsis being maintained. The same result may be secured by passing needles through the skin under the veins and applying figure-of-eight ligatures over them, compressing the vessels, both to be removed in five or six days. The insertion of a small piece of rubber tubing beneath each ligature, by its elastic pressure, increases the probability of adhesive occlusion. Sub-cutaneous division of the veins on the protected side of each needle makes occlusion certain. In special cases short sections of veins may be dissected out, the severed ends being ligated.

The old practices of applying caustic pastes or of injecting coagulating solutions are to be condemned, because of unnecessary risk of phlebitis and embolism. No method of treatment should be undertaken in which asepsis cannot be maintained throughout.

**Thrombosis.**—Coagulation of blood in the blood vessels during life is called thrombosis, the coagulum a thrombus. The appearance and composition of thrombi vary with the circumstances of their formation; one rapidly formed in blood not in motion will be soft and red from entanglement of the red globules; one more slowly formed in moving blood will be buff-colored, quite firm in texture, and composed of fibrin and white corpuscles in alternate layers; one formed where the blood is alternately at rest and in motion may be striated, red and buff, or pink. Intra-vascular coagulation depends on two factors, usually coexisting, morbid alteration of the vascular wall and stoppage of the circulation. Varicose veins present both these conditions. Fibrin ferment produces frequent thrombi. They grow by accretion and have some disposition to cease growth when an active current of blood is encountered, but may extend into it with or against the stream. A thrombus may adhere to one side of a vessel (parietal), permitting flow of blood along the other, or it may occlude it. Where the principal vein of an extremity is obstructed edema, "white swelling," is produced. After increasing for variable

periods thrombi tend toward disintegration by simple red softening, by puriform or yellow softening, by contraction and by disorganization. In simple softening, the common mode in varicose veins, the thrombus liquefies from within outward, becoming converted into a grayish or reddish mixture of shriveled blood corpuscles and granular debris. The fragments gradually pass off in the circulation as emboli and lodge in the branches of the pulmonary artery; but, being aseptic, they generally produce no serious results. In yellow or puriform softening micrococci are present, producing inflammation of the veins, to be treated under the head of phlebitis. Detached fragments become infectious emboli in the lungs or liver and excite serious secondary inflammation.

Contraction with calcification is an occasional termination. Organization with occlusion of the vessel is the natural and safe method of disposal of thrombi formed after ligation or in ends of severed vessels. In superficial veins the presence of thrombi may be ascertained by palpation and occasionally by sight. Slight tenderness is present, but no local inflammation or general fever occurs without accompanying phlebitis.

The treatment of thrombosis is rest, with avoidance of manipulation or movements that may force clots into the circulation. A moist dressing hastens somewhat the process of resolution and helps to keep the limb warm.

**Phlebitis.**—Phlebitis is an inflammation of all the coats of a vein. Endophlebitis, mesophlebitis and periphlebitis are terms used to designate inflammation of the separate coats. The endothelial cells of the inner coat are smaller than those in arteries and are imbedded in a fibrillated basement substance. The elastic and muscular elements are much less developed than in arteries, the separation between the outer and middle layers often being indistinct. Some veins, as the intra-cranial sinuses and the veins of bones, have no muscular tissue, and the large venous trunks, especially those in the upper part of the body, as the jugular, sub-clavian, and *venæ cavæ* have little. The direction and arrangement of muscular fibres also vary. The elastic layer directly invests the inner coat and extends outward in a network through which the muscular and connective tissue elements are interwoven. The *vasa vasorum*, and in larger veins the branches of the sympathetic nerves, follow the connective tissue bundles downward to the elastic layer next the intima.

The valves are reduplications of the serous lining membrane, containing a small amount of elastic tissue and a small amount of muscular along the attached margin, a suggestion of the better developed valves of the heart.

The part of the vein having a muscular supply, i. e., that external to the intima is the first affected in inflammation. The inner coat as a result becomes cloudy, thickened and rough and may become separated in shreds. (Frey.)

During the earlier stages the capillaries of the *vasa vasorum* are swollen, the white corpuscles migrate into the extra-vascular spaces, the connective tissue cells undergo rapid proliferation, and general thickening results. The endothelial layer is pushed inward by the swelling, and its cells rapidly multiply, but are diminished in vitality. In a few days granulations and new capillaries may push through the thickened intima and into the thrombus contained in the vein.

The thickening of the wall, roughening of the inner surface, and the



stasis of blood soon cause the formation of a thrombus, which may adhere to the wall (parietal thrombus) so as to admit for a time of passage of blood on the other side, or grow centrally around a non-adherent nucleus till it occludes the vessel (occlusion thrombus). The formation of a thrombus, though it impedes circulation and entails dangers of embolism from detached fragments, yet opposes a barrier to the osmosis of septic matter from the surrounding connective tissue that would otherwise pass freely into the circulation and be distributed to distant points, and thus is a conservative effort of nature. Opinions differ as to the cause of coagulation, but so delicate is the sensibility of the blood to mechanical irritation, or hindrance to its flow, that the slightest injury or roughening of the endothelial lining membrane may produce a desposit of fibrillated fibrin. A delicate needle or wire, or thread, thrust into the lumen of a healthy vessel precipitates coagulation upon the foreign body. The white corpuscles are found clustered in great numbers about the foreign substance, and when the mass is examined with the microscope the corpuscles seem to serve as starting points for the deposit of fibrin. (Reichert.)

**IDIOPATHIC PHLEBITIS.** This form is comparatively rare and seldom occurs except in varicose veins of the lower extremity. Causes ascribed have been exposure to cold, fevers, syphilis and gout.

**TRAUMATIC PHLEBITIS.** This may be produced in a great variety of ways, some of which are by ligation and injuries that wholly or partially sever or contuse the vessel. If infection be added to trauma perfect conditions for phlebitis are supplied. In arteries the flow of blood is toward the periphery, and the high pressure tends to prevent entrance of foreign or infectious matter; but in veins the current is the other way and absorption is easy.

Signs of local inflammation and general fever serve to distinguish phlebitis from thrombosis, though thrombosis may cause phlebitis. Absence of glandular enlargement distinguishes phlebitis from lymphangitis, unless both co-exist.

The process may terminate by resolution, suppuration or gangrene. In favorable cases the fever subsides and the inflammatory infiltration and coagula disintegrate and are carried away. When infection has occurred suppuration follows. With the breaking down of coagula detached fragments are sometimes conveyed to distant parts to become infectious emboli. Serious and fatal pneumonia is a possible consequence while if emboli pass through the portal veins abscess of the liver results. Suppuration is indicated by the usual signs, rigors, increase of fever, and perspiration. Pus should be evacuated as soon as located; coagula in the veins beyond prevent hemorrhage after incision. When vitality is low or extensive occlusion of vessels occurs gangrene may ensue; in such cases local conditions are bad enough, but the terrible depression of septicemia makes the prognosis graver. When the strength of the patient and the limitation of the disease admit amputation may save life.

**TREATMENT.** The general treatment of phlebitis should be a moist antiseptic dressing locally at all stages, with artificial heat to the foot when the veins of the lower extremity are affected. Manipulation should be avoided on account of the danger of forcing coagula or pus into the circulation. The patient's strength should be kept up as much as possible by nutrition and stimulation. Internally arsenicum, secale, or hepar sulphur may be given.

## CHAPTER IV. DISEASES OF ARTERIES.

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**Arteritis.**—The arteries have three coats, the outer two of which vary considerably in development in different parts of the system. The inner coat consists of a double layer of pavement endothelial cells, with their long axes parallel with that of the vessel and resting on a fibrillated basement substance; the middle, of the elastic and muscular elements in a network of connective tissue; the external, of connective tissue, supporting blood-vessels, lymphatics and nerves.

The arteries convey a fluid circulating rapidly under high pressure and subject to ceaseless violent impulses of the heart. Elasticity and contractility are very important for the proper exercise of their function, and impairment of this quality from any cause produces mechanical incompatibility liable to serious consequences. Bodily power is maintained in harmonious development only by proper exercise; a muscle if little used atrophies, so does an artery. Active exercise that quickens and strengthens the pulse keeps the arteries in tone. In the young and middle-aged this is accomplished by play or labor which is sometimes over-done; but the quiet inactive habits of many people in declining years allow their arteries to deteriorate, so that with the added causes of traumatism and constitutional discrasia they are frequently diseased. Excessive vascular development in early or middle life from arduous occupations is particularly liable to be followed by arterial degeneration in an inactive old age.

Arteritis may involve all the coats of a vessel or one only; from the latter circumstance distinctive names, as *endarteritis*, *mesarteritis*, and *periarteritis*, have been given; but the distinction is of little moment to the practical surgeon.

In inflammation the inner coat is particularly liable to swell so as to cause partial or complete occlusion of the vessel; if the smooth inner surface become roughened by ulceration or detachment of cells, desquamation of coagulum from the blood (thrombosis) aid in producing occlusion.

Local thickenings of the inner coat of a chronic character constitute what has been termed sclerosis. Flat or convex elevated patches with steep or sloping margins appear in arteries of all sizes, from the aorta to the smallest branches. They vary in appearance from that of a transparent gelatinous substance to a dense, white, fibrous tissue. Sometimes they are few in number, but again are so numerous as to about cover the surface.

If the sclerosis is marked there are formed other patches of a white or yellow color, some of which may present a smooth surface while others will have broken down. These are called *atheromatous patches* and *ulcers* and are regarded as sequelæ of sclerosis.

Syphilis not only disposes to atheroma but to gummy deposits in and about the arterial wall that may narrow or occlude its lumen. The arteries of the brain are particularly subject to this lesion, and serious, sometimes fatal, consequences ensue from it.

It is in the middle coat that true fatty degeneration and calcareous deposits take place. The external coat is subject to inflammatory thickening with occlusion of the *vaso vasorum* that diminishes the nutrition of the middle and inner coats.

**ACUTE ARTERITIS.**—This form may result from direct traumatism, extension of inflammation from adjacent tissue, or lodgment of an infectious embolus. It figures in the surgical field mainly through its liability to cause gangrene by stopping the circulation in important arteries.

**CHRONIC FORM.**—By chronic arteritis is meant the process by which atheromatous degeneration develops. Traumatism, alcoholic excesses, syphilis, rheumatism and gout have been regarded as causes. With the morbid thickening of the inner coat thinning and weakening or involvement of the middle one occurs, so that atheroma conduces to aneurism and apoplexy.

Calcareous deposit occurs in the middle coat, sometimes in laminae, sometimes in tubular form, occasionally occurring in connection with atheroma of the inner coat and serving to prevent the dilatation or rupture to which the latter condition disposes. It affects particularly the arteries of the extremities, and by narrowing or closing them causes senile gangrene. The hardened vessels can often be felt. Calcareous degeneration and atheroma are developed in advanced life, supposedly from local malnutrition.

**EMBOLISM.**—By this term is meant the obstruction of an artery by some foreign substance, generally a blood clot or a piece of broken-down vessel. Endocarditis and atheromatous degeneration present conditions favoring coagulation (thrombosis) at sites where fragments may be readily swept away to distant parts. Debris from the disintegration of atheromatous patches is sometimes the obstructing substance.

The obstruction of an important artery of an extremity causes pain at the point of lodgment, disappearance of pulse in the vessel beyond, coldness and tendency to gangrene from anemia.

**TREATMENT.**—The treatment of arteritis, acute or chronic, is mainly medical, and directed toward the disease that caused it. In sudden occlusion of important vessels of the extremities encouragement of collateral circulation, by artificial heat and favorable position, should be added to therapeutic treatment. In slowly occurring closure of vessels, collateral circulation has time for establishment and will take place where there is opportunity; but in the lower extremities all sources of supply are frequently cut off and gangrene follows. As previously stated, judicious exercise will do much to prevent arterial deterioration, but, after it has occurred, over-exertion or excitement is dangerous.

**Aneurism.**—Aneurism is a tumor with a cavity containing blood and communicating with an artery. Two principal kinds have been described; one in which the tumor has been formed by dilatation of one or more coats of the artery, and called true or idiopathic aneurism, the other having a newly formed sac containing blood that has escaped through all the coats of the artery, and called false or traumatic aneurism. The sac in traumatic aneurism is formed by cohesion of white blood corpuscles and colorless fibrin; if inflammation occur granulations and new capillaries may spring up so that it becomes fully organized. (Ziegler.)



A fusiform or tubulated aneurism is one in which all the coats of an artery over an extensive area have been dilated. When distention has been great the fibres of the middle coat have been separated so that they do not constitute a continuous layer. This variety is apt to develop in the cranial, thoracic, and abdominal cavities; it is not liable to become very large nor to rupture. (Fig. 425.) Because of the absence of a recess in which blood can stagnate coagulation and deposit of fibrinous laminae do not occur. Pain and an exaggerated pulsation cause the patient considerable distress, and help in diagnosis; but, when developed in the usual sites, there is no remedy.

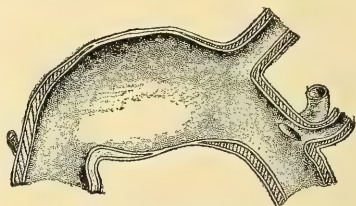


Fig. 425. Tubulated Aneurism.

In sacculated aneurism the cavity communicates with the artery through a variable but comparatively small opening. The tumor may attain great size and may endanger life by pressure on other organs, by

rupture and hemorrhage, or by gangrene, sepsis, or cerebral embolism.

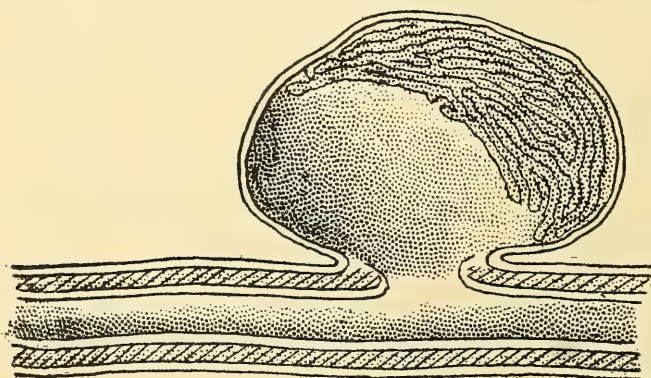


Fig. 426. Section of Sacculated Aneurism.—Exaggerated.

A thoracic aneurismal tumor may cause death by pressure upon the trachea, bronchus, or lung, causing asphyxiation; upon the esophagus or thoracic duct, causing inanition; or

may rupture externally or into any mucous or serous cavity. Death from hemorrhage is not always sudden; rather, the gradual sloughing of the thinned walls causes repeated bleeding that finally exhausts the patient.

Because the cavity of a sacculated aneurism affords a favorable site for the coagulation of blood it has a tendency toward spontaneous closure, that in rare cases becomes complete and curative; embolism of the artery near by from detached coagulum has been known to produce spontaneous cure, but such lucky accidents are not common.

**DIAGNOSIS.** In diagnosis the tumor is found to pulsate, but the pulsation varies according to the age of the tumor and the amount of fibrinous deposit within. The deposit is apt to be more on one side of the cavity, and pulsation is greater on the other. The pulsation may be diminished or arrested by compression of the artery on the proximal side, and where not much coagulation has occurred the blood may be expressed from the tumor till it is much reduced in size. Other tumors in contact with an artery transmit pulsation in a direction perpendicular to the artery, but that of aneurism has a distensile quality that may be felt by grasping the tumor. On auscultation the bruit caused by the to and

fro rush of blood is heard. When the tumor is of much size and pulsates freely the pulse in the artery beyond will not be synchronous with the heart beats.

Dissecting aneurism is a variety where the inner coat of the artery has given away and the blood forces a passage longitudinally along the middle coat until a weak spot is found in either the outer or inner coat. If the outer yields blood is extravasated into the connective tissue or a sacculated tumor is formed; if another atheromatous spot in the inner coat is reached a second communication with the channel of the vessel is made. Occasionally neither the outer nor inner coat gives way and a small sac between the walls remains. Fortunately for diagnosticians this variety of aneurism is rare.

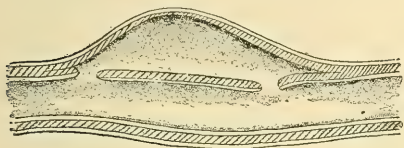


Fig. 427. Dissecting Aneurism.

oment of aneurism. It occurs more frequently in middle life and in the male sex. That women are nearly exempt is doubtless due to their avoidance of dissipation and non-engagement in arduous occupations that require violent action of the heart.

Aneurism occurs more frequently in newly settled districts where violent modes of life prevail, and is less common in warm climates than in cold ones, where more vigorous circulation is needed. It does not often develop in old men with sclerosed or atheromatous arteries, because of their common indisposition and inability to keep up continued violent heart-action, apoplexy being the sequel to their arterial degeneration.

**TREATMENT.** The treatment of aneurism is mainly by assistance and imitation of the natural effort toward cure. Closure of the sac by blood clot should be secured, if possible, in the safest manner. Reduction of the heart's impulse favors this result. A minimum of agitation of the blood is obtained by continuous rest in a horizontal position, but the deterioration of all the tissues is so great in confinement in bed that this restraint should not be resorted to except in cases of internal aneurism not amenable to other treatment. Iodide of potash and ergot increase the coagulability of the blood. They are given in material doses for their physiological effects. Helmuth reports most excellent results from prolonged administration of gallic acid in half-drachm doses.

When the tumor is located in an accessible place, temporary or permanent arrest of circulation in the affected artery should be secured in as great a degree as practicable or necessary to produce closure of the sac by coagulation. Pressure and ligation are the methods by which this is accomplished. Of the two pressure is much preferable where it can be successfully employed; it does not cause permanent occlusion of the artery and a possible gangrene, and entails no risk of infection or secondary hemorrhage. When possible it should be applied over the artery on the proximal side of the tumor in amount sufficient to stop pulsation, or come as near to it as circumstances will permit. It is less effective but may be applied on the distal side when the other cannot be reached.

Digital compression is the form best tolerated by patients, and can be kept up for a number of hours by a relay of assistants. A crutch or



pole with a soft rubber tip and suitably weighted may be kept in a vertical position over the desired location by guy ropes, this form of apparatus having advantage over tourniquets in that the foot of it can be readily moved back and forth along the artery, shifting the point of pressure. Bags of shot have been satisfactorily used in some instances. Whatever method is used pressure should be limited to the artery, if possible; if veins and nerves are included swelling and much additional pain are produced. The length of time for compression to be kept up varies from a few hours to several days, and depends largely upon the degree of impediment to circulation produced. When the compression is relaxed it should be done gradually, as a sudden rush of blood may wash away the soft, newly formed clots. Absence of pulsation after removal of pressure shows when the desired object has been accomplished. Perfect quiet should be maintained for some days afterward.

Rapid solidification has been produced by the Esmarch bandage applied lightly over the tumor, but so as to arrest circulation entirely above and below. Success has been obtained from one hour's application, but usually several hours are needed, with a tourniquet applied for some time afterward. General anesthesia is necessary in this method. By its success may sometimes be attained after failure by others, but it has the risks that attend prolonged anesthesia and those of nerve injury and gangrene.

In cases where compression cannot be applied, or where it has been unsuccessful, ligation may be resorted to. It should be done on the cardiac side of the tumor when possible, and, preferably, with an arterial branch between its site and the affected point. The branch by anastomosis prevents sudden and complete arrest of circulation through the affected portion of the artery; it lessens the risk of sloughing and by dilatation of its anastomosing branches it helps materially in establishing collateral circulation. When there is not room on the cardiac side ligation may be done on the distal side; when the artery has free anastomosis it may need to be done on both sides. Distal ligation of one or two bifurcating branches, as of the carotid or subclavian in aneurism of the innominate, has been done with benefit. After ligation of an important artery in an extremity care must be taken to foster collateral circulation.

*Method of Antyllus.* The earliest known ligations for aneurism were made by Antyllus in the fourth century, and his was the only method practiced for about fourteen hundred years. It was employed for traumatic aneurism at the bend of the elbow, and with antiseptic precautions is still a very acceptable operation for traumatic aneurism of the brachial, axillary, and popliteal arteries. It is performed by applying compression on the vessel, incising and evacuating the coagula from the tumor, locating the opening, dividing the artery at that point, and ligating both ends. Its disadvantages are that the wall of the artery near the opening may be so softened by disease that secondary hemorrhage may occur from rupture of the vessel at the site of the ligature, and the complete obstruction of the circulation may cause gangrene. For these reasons the

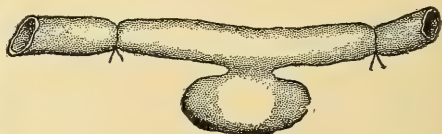


Fig. 428. Ligation After Antyllus.



method should not be resorted to except when the chances for collateral circulation are good, and when others are manifestly inadequate.

*Anel's Operation.*

Anel's operation was introduced in 1710, and was the beginning of modern research in this matter. He did not incise the tumor but ligated the artery just above it, and observed that the pulsation ceased and the tumor was gradually absorbed.

The method is still employed; but of all known methods, where possible the preference is usually given to Hunter's method.

*Hunter's Operation.* This consists in ligation of the artery at a distance above the tumor, where the artery is more apt to be sound, and where a branch between the ligature and the tumor, by anastomosing with those above, prevents complete check of circulation through the affected portion of artery, and helps materially in establishing collateral circulation. This is the ideal operation, when practicable. Contraindications are lack of room, too free anastomosis on the distal side, and inflammation of the tumor. The risks attending Anel's and Hunter's operations are secondary

hemorrhage, return of pulsation in the tumor, inflammation and suppuration of the sac, gangrene of the extremity, pyemia, and septicemia.

*Brasdor's Operation.*

This consists of ligation of the artery on the distal side of the tumor. It is applicable in aneurism of the carotid, external iliac, and other arteries where the artery is not accessible on the cardiac side.

*Wardrop's Operation.*

Wardrop's operation consists in tying the artery on the distal side, beyond a branch. It is done in aneurism of the innominate artery or of the neighboring part of the arch of the aorta, by ligation of the carotid or subclavian, or both. When both have been ligated limited circulation is kept up through branches of the subclavian on the cardiac side of the ligature.

Excision of aneurismal tumors with double ligation, may be done if they are large and accessible; if, in addition, they have begun to slough, and are liable to break down throughout, their removal is most desirable.



Fig. 429. Ligation After Anel.

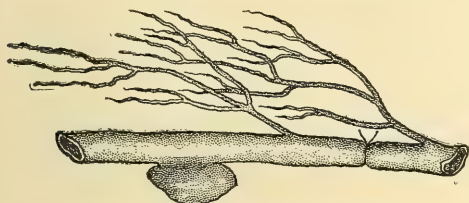


Fig. 430. Ligation After Hunter.

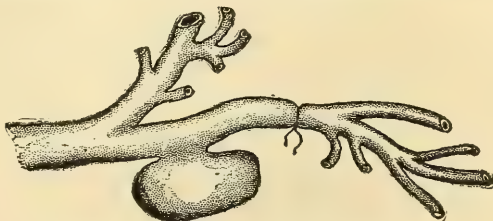


Fig. 431. Ligation After Brasdor.



Fig. 432. Wardrop's Ligation.

This may be done with most safety in traumatic aneurism, where the artery is in a healthy condition except at the opening; in such cases the ligatures must be applied near the opening, according to the method of Antyllus.

Among other methods of treatment kneading of the tumor, with a view of expressing some of the fibrinous deposit to occlude the efferent artery, has been practiced with occasional success. Solutions of iron salts have been injected into the tumors while compression on both cardiac and distal sides was employed. Neither of the last two methods should be considered when the tumors are so situated that the resulting emboli can be carried to the brain. Foreign bodies in the shape of needles, coils of fine steel wire, or horse hair inserted through hollow needles have been introduced to entangle and promote coagulation of blood. Delicate sacrifice of the inner surface of the sac by needles thrust through it has been quite a successful means of exciting deposit of fibrin. When possible to apply it, simultaneous arterial compression will increase the probability of success by any of the last named methods.

**USUAL LOCATION.** *Aorta.* The arch of the aorta, particularly the ascending and transverse portions, having little elasticity, being so near the heart and having to turn the current of the blood, is the most frequent of all to yield and allow the development of aneurism. It is more often of the fusiform, but is sometimes of the sacculated variety. Pain and pressure upon the trachea or bronchus, causing cough or dyspnea; upon veins, causing stasis above, or upon the recurrent laryngeal nerve of the left side, causing laryngeal paralysis are the earlier signs. Not until the dilatation has attained some considerable size can its presence be made out by physical examination. By pressure the tumor sometimes causes absorption of the sternum, ribs, clavicle, or bodies of vertebra. From its location it admits of little local treatment. When at the base of the innominate artery ligation of the carotid and subclavian has been done with some degree of success; but experience in this line has been very limited. General treatment in the way of rest in the horizontal position, restricted diet, and internal medication must be the main dependence in postponing the fatal termination of the disease.

*Innominate.* Innominate aneurism usually appears at the upper margin of the sternum, and is apt to be confounded with that of the arch. A diagnostic sign sometimes present is a lagging of the pulse of the right side behind that of the left. In this kind of aneurism ligation of the carotid, of the subclavian, or of both has been practiced; ligation of the subclavian is considered the safest.

*Subclavian.* Subclavian aneurism of the right side may be in the first portion, extending from the innominate, or in the third portion. It presents a pulsating tumor external to the sterno-mastoid muscle, or external to the scaleni. Ligation, distal or proximal, according to location, has been done.

*Axillary.* Axillary aneurism is apt to be traumatic, consequent on dislocation of the humerus or reduction of the same, or from external violence. It grows rapidly, attains a great size and by pressure upon the vein causes swelling of the arm. If the tumor is small, treatment by bandaging the arm below and compressing the artery on the first rib may be tried. If not successful, or if the tumor is large, with compression applied in the

same way, the tumor should be laid open and emptied of contents, the opening found, the artery divided and ligated above and below.

*Abdominal Aorta.* Aneurism here is apt to be fusiform; its presence is indicated by pain and exaggerated pulsation. Sacculated aneurism in this locality has been successfully treated by compression.

*Femoral.* Femoral aneurism of the traumatic variety is frequent from the superficial and exposed position of the artery. Diagnosis is easily made. Treatment by compression should be most faithfully tried before resorting to ligation. If ligation be done it should be above an anastomosing branch, if possible; when that is not possible it may be done distally.

*Popliteal.* Popliteal aneurisms constitute about one-fourth of all cases, and are generally traumatic. If seen while small treatment by compression should be undertaken, if large or beginning to slough, by excision and double ligation.

**ANEURISMAL VARIX.** Fig. 433. This is a venous dilatation resulting from communication between an artery and a vein without an intervening sac. It is the result of a penetrating wound, looks like a varicose vein, but pulsates and affords a purring sound on auscultation. This lesion may exist for years and result in no more serious trouble than a varicose condition of veins beyond the junction, caused

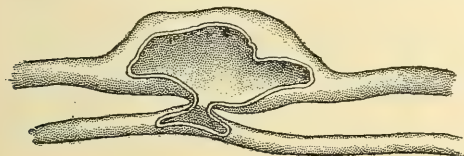


Fig. 433. Aneurismal Varix.

by the high arterial pressure transmitted to them.

If treatment be undertaken it may be by compression of the artery above and the vein below and upon the varix; if that is not successful double ligation of both vessels separately and excision of the sac may be employed.

**VARICOSE ANEURISM.** Fig. 434. Varicose aneurism is like the above except that there is a false aneurismal sac between the vessels. Because of the vent into the vein this sac does not grow large, but it is apt to degenerate and permit extravasation of blood.

The treatment is by ligation of the artery above and below the affected point, without disturbance of the sac.

**ARTERIAL VARIX.** This is an elongation and dilatation of a small or medium sized artery extending over some distance, and is analogous to venous varix. It is most frequent in the superficial temporal, posterior auricular and occipital arteries, and is apt to cause troublesome hemorrhage from ulceration of the thinned, overlying skin.

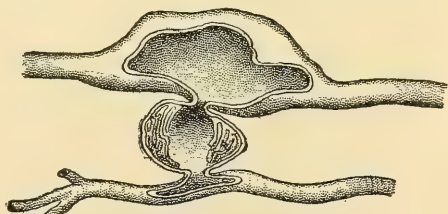


Fig. 434. Varicose Aneurism.

**CIRSOID ANEURISM.** Cirsoid aneurism is a plexus of varicose arteries and capillaries. It forms a pulsating tumor but can be distinguished from aneurism by its location, its irregular contour, its color, its greater compressibility from absence of coagulum within, a more elastic and doughy feel and a modified bruit.



The treatment is excision, multiple ligation of supplying arteries, ligation of main artery, and injection of coagulating fluids.

**Nevi.**—Nevi, or birth marks, consist of plexuses of dilated capillaries of the skin or of small veins in or beneath the skin. They are seen on the face, head and trunk, and sometimes increase in size after birth. They are red or bluish and of variable elevation above the level of the skin. Venous nevi are also found beneath the skin, in the orbit, liver and other deep lying tissues.

Treatment depends on the character of the mark. If it is only slightly elevated and consists of a thin layer of dilated capillaries it can be treated by closely apposed parallel incisions made with a keen gum-lancet and extending through the layer of dilatation. By the subsequent healing of the incisions narrowing or obliteration occurs, leaving no scar. In about two weeks the treatment may be repeated with the incision cross-wise to those previously made, and the process may be continued as long as seems desirable. If the plexus forms a thicker, more prominent mass, it may be made the site of vaccination, may be excised, ligated, injected with coagulating solutions, or punctured with the galvanic needle. Sewing the mass through and through in different directions with thread that has been wet in subsulphate of iron solution and dried is a safe and convenient method of causing coagulation of blood and obliteration of many of the vessels. Injection of alcohol, a few drops at a time, may sometimes be done so as to cause gradual obliteration of vessels without producing a slough and resulting scar; if the whole dilated plexus is filled with alcohol and sloughing does occur the subsequent scar will be as small as any that can be made by other methods of operation. To most people a white scar is preferable to a red mark. Ligation may be employed by inserting a double ligature under the base of the mass and tying it in two halves, or, if the size requires, by multiple ligatures; sometimes a subcutaneous ligature around the base may be applied so as to strangulate the mass without the production of much scar.

## CHAPTER V. INJURIES OF BLOOD VESSELS.

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**Hemorrhage.**—Hemorrhage occurs whenever the wall of a blood-vessel is divided—from an artery in a more forcible pulsating stream; from a vein in a darker continuous flow. When it has free exit the blood will appear on the surface of the body; otherwise it will be accumulated in any cavity, or infiltrate the connective tissue, forming hematoma. Internal hemorrhage may be suspected from sudden pallor, fainting, and nausea. The accumulation of blood can be located by physical examination.

The vital centers in the brain are very sensitive to fluctuations in blood pressure, sudden diminution of it suspending the respiratory and cardiac functions and producing syncope that may be fatal. The immediate effect of hemorrhage depends more on the rapidity of it than upon the amount of blood lost, a sudden gush of a small amount of blood creating more temporary disturbance than a much greater loss occurring slowly. In some instances the syncope from the reduction of pressure causes spontaneous cessation of hemorrhage.

Hemorrhages are classified, from the time of their occurrence, as immediate, intermediary and secondary. In the first there is no interval of time after the injury of vessels and its occurrence; intermediary succeeds in from half an hour to twenty-four hours, and is due to reaction or the disappearance of local vascular spasm that has temporarily restrained the flow of blood; secondary hemorrhage occurs after twenty-four hours, more commonly in from five to ten days; it results from the softening of the thrombus or the giving way of a ligatured or injured vessel, and is much more liable to happen when a suppurative or gangrenous condition is present. Gun-shot wounds in which the vessels have not been divided or opened but are badly bruised and infected are particularly liable to secondary hemorrhage.

Bleeding from capillaries and vessels of small size generally ceases spontaneously from retraction, contraction and closure by coagula. Vessels of larger size do not bleed much when divided by a tearing or crushing force, so that surgical interference is needed mainly in hemorrhage from larger vessels or those that have been abruptly divided.

**TREATMENT.** The treatment is local and general. In sudden hemorrhage direct digital compression is the readiest remedy. In almost any case amenable to surgical treatment the flow may be checked by the finger till other means can be applied. In some cases, where the bleeding vessel is not large, and when it cannot be seized with forceps without further incision, continued pressure by compress and rubber bandage may meet all requirements. Venous hemorrhage can generally be controlled in this way, but care should always be observed that the pressure does not simply prevent external escape of blood at the expense of sub-cutaneous infiltration. When the bleeding vessel is readily accessible, or when it is

manifestly too large to be managed by compression, it should be ligated in the wound. It is generally done with sheep-gut, after seizure with hemostatic forceps. In small or medium-sized vessels the author prefers a silk-worm ligature passed down through the adjacent skin into the wound under the vessel then back to the surface again near the point of entrance and tied; unlike sheep-gut buried in the wound it is not apt to slip off, come untied or carry infection, and can subsequently be pulled out, leaving no foreign substance in the tissues.

Intermediary hemorrhage may be prevented or checked in many instances by compression; where ineffective ligation should be resorted to.

In secondary hemorrhage the artery may be ligated in the wound, if conditions permit, but it should generally be done through a new incision in sound tissues. In gunshot wounds near large arteries and in sloughing or gangrenous stumps after amputation, where secondary hemorrhage is particularly to be feared, patients should be closely watched lest a fatal bleeding occur before it can be remedied.

In attending a case of hemorrhage still continuing local treatment should first be afforded. If the patient has fainted and the bleeding stopped, restoration should be the first effort. Lowering of the head will lessen cerebral anemia, and as absorption of warm fluid to restore a working volume and tension in the blood-vessels is rapid this fluid should be supplied. If the patient is unable to swallow, a couple of ounces of warm sterilized water with a little whisky in it may be thrown into the connective tissue; the prick of the needle may help revive the person, and this is probably the quickest way to get a little water and stimulant into the circulation. Warm flushing of the colon also helps to restore lost volume of fluid. As soon as the patient can swallow he should be kept sipping hot water.

*Transfusion.* Transfusion of the blood has been practiced with some success, but the risk of phlebitis and embolism is so great that it has got beyond the experimental stage, and is resorted to less frequently than formerly. Intravenous injection of saline solutions has been productive of as beneficial results with less danger. In ordinary private practice the urgent necessity for it is over before the apparatus can be got ready. If it be done it must be with proper precautions against infection and admission of air.

Loss of blood having been stopped and the patient restored further treatment is dietetic and medical.



SECTION XIV.  
**SURGERY OF THE GLANDULAR SYSTEM.**

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CHAPTER I.  
**DISEASES OF THE LYMPHATIC GLANDS.**

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**General Considerations.**—The position occupied by the lymphatic glands in the human system is one of special exposure to noxious matters entering through the skin or mucous membranes. They are the foci to which the lymphatic vessels converge from all parts of the periphery. Many of the vessels have their origin in open spaces of the sub-cutaneous connective tissue, and others upon or very near the surface of the mucous membranes. Their mouths are wide open to absorb everything possible within reach and keep the tissues clear of debris. In addition to the natural fluid obtained from the blood vessels and the waste of the tissues, foreign substances, disease germs and products, even to those of pyemia and septicemia, come within their grasp. Sentinel phagocytes guard many of the avenues of entrance to them, so that in vigorous healthy people the field is well fortified; but in the weakly the defenses are often down. Of all places in the body the throat, the cross-roads where all the food and drink and air and their contaminations pass, is most often found weak. In many persons the lymph channels in this locality have defective and illy-protected origins. Contaminating matters enter the vessels, pass along till arrested by the fine capillary divisions within the glands of the neck, where they excite irritation in all degrees, up to inflammation and suppuration. Next to those of the neck the glands of the groin and axilla occupy the most vulnerable positions. Disease may originate in the glands themselves, particularly after injury, but in the great majority of instances the exciting cause is brought in from somewhere else by the lymphatics.

**Acute Lymphadenitis.**—Lymphadenitis, or simple adenitis, is acute, subacute, or chronic.

In acute lymphadenitis rapid accumulation of leucocytes takes place, and the gland and surrounding connective tissue swell quickly. Pain and tenderness are marked. By ascertaining definitely the location of the enlargement and by exclusion of other possible causes of swelling the diagnosis is generally easy.

In favorable cases the altered white corpuscles are re-absorbed and the inflammation terminates by resolution and restoration of the tissues to integrity in a few days. In some instances foci of suppuration form and the abscess grows beyond the limits of the gland into the connective

tissue toward the surface, where it breaks spontaneously, unless anticipated by incision. If the gland has been pretty completely destroyed by the suppuration, and others do not successfully break down, the cavity soon closes; but, if gland destruction continues, a sinus persists indefinitely.

Occasionally the gland tissue does not progress gradually to destruction, but necroses outright. Such a gland is friable in texture, of grayish or darker color, and excites destructive change in the surrounding tissue, with corresponding constitutional disturbance.

Obliteration, induration, and caseation, are other terminations of acute inflammation, but belong more properly among the chronic diseases of the glands.

**TREATMENT.**—The treatment of acute lymphadenitis is largely medical. Aconite, belladonna, mercurius, iodum and hepar are the most frequently indicated remedies. Belladonna ointment externally, or a three per cent. solution of carbolic acid injected in the gland, has a good effect in the earlier stages before pus has formed. Hot antiseptic compresses are also useful. When pus has begun to form hot fomentations or a moist dressing afford a grateful relief, and, doubtless, hasten the suppurative process. As soon as the pus can be located, and before any white spot appears on the skin, a free incision should be made and any remaining portion of gland not consumed by suppuration removed by a curette. Antiseptic cleansing and drainage should follow. Chancroidal buboes may be “shelled out” as soon as suppuration is well under way, and the period of illness be much shortened. If necrosis of a gland has occurred its early removal helps to limit the septicemia and the extension of the local destructive process.

**Chronic Lymphadenitis.**—In chronic lymphadenitis there is generally an increase in bulk due to the formation of new cellular tissue. Its structure usually bears little resemblance to that of normal lymphoid tissue, and is often so like neoplastic or tumor tissue that it is difficult to determine whether it is such or not. In diagnosis the clinical history must be considered.

Chronic enlargements of the lymphatic glands of inflammatory origin are divisible into three groups, according to their histological structure: Small-celled hyperplasia with a tendency to caseation or suppuration, commonly described as scrofulous lymphadenitis, or tubercular enlargement; large-celled indurative hyperplasia; trabecular or reticular indurative hyperplasia. All these varieties are generally known as lymphoma.

**LARGE-CELLED INDURATIVE HYPERPLASIA.** Distinguished by the transformation of the normal gland tissue into a large-celled tissue having none of the characters of the original structure. The large-celled tissue consists in part of close-packed, rounded or polygonal cells, and in part of spindle-cells. There is little intercellular substance, though in some spots distinct patches of fibrous tissue are seen. The development of large cells is sometimes in separate masses, so that there is a nodular as well as a diffused form of enlargement. The nodular variety on palpation seems very similar to tuberculous enlargement. Large-celled hyperplastic glands feel firm and dense and may attain the size of a small egg. Firm caseation is the more frequent form of degeneration.

**FIBROUS INDURATIVE HYPERPLASIA.** Caused by long continued deposition of foreign substance in the glands, and by chronic or often repeated inflammation. Affected glands are increased in size as well as indurated. The capsule and fibrous septa are first and most largely involved, showing conspicuously upon section. The most typical forms are seen in cases of elephantiasis. When the hyperplasia is more generally diffused, the gland upon section has a uniform light gray tint and is uniformly dense and firm.

**SCROFULOUS LYMPHADENITIS.** This form is closely related to the ordinary acute inflammation and is often a result of it, though it generally runs through a sub-acute or chronic course. The glands swell to considerable size, and the number affected varies from one to an entire group. In the early stage the chief microscopic change is the great accumulation of small leucocytes in the meshes of the adenoid reticulum. This is little altered at first, but later on it breaks down here and there. When necrosis or caseation sets in the usual degenerative metamorphoses are visible; the cellular tissue is replaced by a mass of detritus, and only the nuclei at the margins where the dead tissue passes into the living can be brought out by staining re-agents. When caseation occurs it may be about several foci or the whole gland may be involved. The tissue surrounding the caseous foci at first consists of infiltrated lymphoid tissue; afterward it becomes more fibrous. The capsule of the gland is specially liable to become thickened.

**TUBERCULOUS LYMPHADENITIS.** This form is very common. The tubercle bacilli reach the glands by way of the lymphatics, so that the glandular affection is often secondary, though the cervical glands especially become primarily tubercular. The germs are absorbed in the throat and carried to the glands before effecting lodgment.

Tubercular glands are often greatly enlarged and are firm and fleshy in texture. Upon section the tubercles appear as small, grayish-white, translucent nodules; later, after caseation, they are opaque, yellowish-white, and more easily detected. In many instances diagnosis can be made only by microscopic examination. The glands most affected are those of the mesentery, root of the lung and neck.

**TREATMENT.** The treatment of lymphoma in its different forms is mainly medical. Next to hereditary predisposition defective nutrition and air starvation are probably the leading factors in the development of the constitutional depravity that paves the way for chronic disease of the lymphatic glands. Good hygiene and good homeopathic prescribing in the earlier stages many times correct the difficulty. Attention to lesions in the throat and nose will often prevent disease of the cervical glands and will help materially in the treatment after they have become affected.

The surgical treatment of lymphoma consists in the removal of the glands after they have begun to break down. The author has removed as many as thirty from one side of the neck.\* The unsightly scars that have resulted from extensive and prolonged suppuration of cervical glands may be sometimes excised with considerable cosmetic improvement.

**Tumors of the Lymphatic Glands.**—Non-inflammatory tumors of the lymphatic glands constitute two groups, those in which the tissue is of the normal lymphadenoid character and those in which this tissue



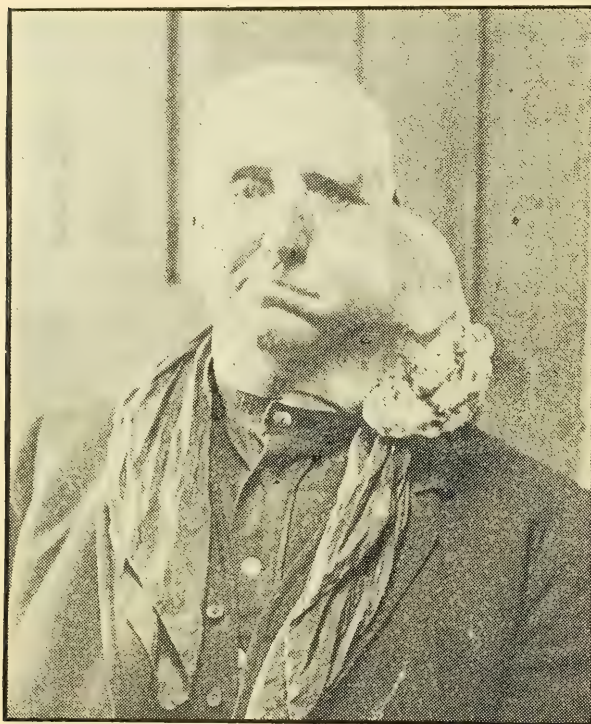
has been displaced by a different kind. They have been designated as lymphomata and sarcomata. Many of the homeoplastic formations have the anatomical characteristics of hyperplasia rather than of neoplasm. That the glandular function is increased is shown by the increase of white blood corpuscles (lukemia), other growths (malignant lymphomata) form metastases and cause cachexia with emaciation, dropsy, coma, delirium and death.

Clinically it is difficult to distinguish hyperplastic from neoplastic growths, and the confusion is not lessened when tumors that appear to be histologically identical are accompanied by alteration of the blood in one case and not in another.

**SOFT LYMPHADENOMA.** Lympho-sarcoma is a soft, almost fluctuating growth with a grayish tint upon section. Microscopic examination shows great multiplication of tissue like that of normal gland follicles, with

absorption or lack of increase of fibrous tissue. The surrounding tissue does not become involved, though neighboring glands sometimes cohere and become a single mass. Caseous patches sometimes form. The disease may be limited to one or two glands or an entire group may be affected. Lymphadenoid changes are also liable to occur in the Malpighian bodies of the spleen and in the lymphadenoid tissue of the tongue, stomach or intestine.

Two varieties have been noted. The one, in which there is no change in the blood, other than a diminution of the whole quantity, has been called Hodg-



**Fig. 435. Lympho-Sarcoma of Parotid and Lymph Glands of Neck.—Mitchell.**

kin's disease, adenia (Trousseau), lympho-sarcoma in a restricted sense (Virchow), malignant lymphoma (Billroth) and pseudo-leukemia (Conheim). In the other variety the white corpuscles of the blood are increased in number, and the growth is called leukemic lymphoma. Examination of the blood serves to distinguish the two varieties. In the leukemic form deposits of white corpuscles in diffused or conglomerate masses occur in various tissues, but should not be mistaken for lymphadenoid growths. The spleen is affected in both varieties, but much more so in the leukemic.

*Treatment.* This is medical and palliative. The result is fatal through progressive anemia and emaciation. Extirpation of glands when the disease seemed confined to a few has been of no avail in checking its course.

**HARD LYMPHADENOMA**, or lympho-sarcoma, occurs as a primary growth most frequently in the superficial glands. It extends from one to another, involving a whole group or more. Single glands attain the size of a walnut. Fatty degeneration, calcification, or softening rarely supervenes. The spleen is never primarily affected, and leukemia does not occur.

**SARCOMA OF THE LYMPHATIC GLANDS.** (Fig. 435). Sarcoma of Parotid and lymph glands of neck.—Mitchell. This is somewhat uncommon. It occurs in single glands or several of a group, and often involves adjoining tissue. Secondary growths are usually developed. Small round-celled sarcoma, spindle-celled sarcoma, fibro-sarcoma and alveola or alveolar angio-sarcoma are forms that occur. The latter somewhat resembles carcinoma. Clinically this form of tumor may be suspected from rapid growth without inflammation.

*Treatment.* Treatment consists of removal, with incisions carried wide of the affected glands.

**SECONDARY GROWTHS.** All forms of tumor that give rise to metastases affect the lymphatic glands. Cancers, especially, are disseminated through the lymphatic system; the glands are a common site of recurrence after removal of malignant tumors. Sarcomatous metastases are less common, but may occur.

*Treatment.* Tumors of lymphatic glands are treated by removal, when conditions permit. In extensive involvement of deep and superficial glands, it is manifestly useless to remove superficial ones; but, when the morbid enlargement is confined to superficial glands and the tumefaction causes annoyance, with a constant suggestion of malignant disease, extirpation is a most justifiable procedure.

**Salivary Glands.**—These glands are located superficially where they are exposed to injury; they are the special site of affection in one of the zymotic diseases—mumps—are frequent points of metastasis in pyemia, and are subject to morbid growths of a non-inflammatory character. The ducts are liable to injury or disease, causing salivary fistulæ to open on the skin, and calculi sometimes form in them.

**MUMPS.** Parotitis is a contagious disease characterized by inflammatory swelling of the parotid and sometimes of the sub-maxillary glands. Occasionally the enlargement is confined to one side, but usually extends to both. In rare instances metastasis to the mammæ or testes occurs. Great intolerance of sour articles of food and drink is exhibited. Constitutional disturbance is generally slight, but marked cerebral symptoms sometimes appear. The glandular swelling nearly always terminates by resolution in a few days' time. Occasionally fibrous induration or suppuration ensues.

*Treatment.* As the disease is usually mild and is self-limiting treatment is not apt to be called for in most cases. Belladonna, mercurius or rhus may mitigate the symptoms.

**ABSCESS OF THE PAROTID.** This may result from simple inflammation, from injury, from typhoid fever, erysipelas, smallpox, or other



eruptive disease, or from pyemic metastasis. Because of the firm texture of overlying parts the pus is not apt to seek the surface directly, but to follow the sheaths of the cervical vessels upward or downward, or to burrow toward the ear. Such abscesses open spontaneously into the auditory canal more frequently than elsewhere. They should be incised as soon as the general symptoms indicate suppuration, without waiting for fluctuation to be detected. The incision should be made in the most prominent part of the swelling, and with reference to the branches of the facial nerve superficially and the blood vessels more deeply. A small incision should be made, dilated with dressing forceps, and kept open till discharge ceases. The severe pain experienced before the pus finds a vent may be relieved by hot applications; later moist dressings are useful. Belladonna, mercurius, and hepar sulphur are the principal internal remedies. When the glandular affection is secondary to some other diseased condition that affords the main indications for medical treatment.

**GANGRENE OF THE PAROTID GLANDS.** This affection is occasionally seen in adynamic cases of erysipelas, scarlet fever, smallpox, or typhoid fever. Disinfecting compresses may be used locally and arsenic, secale, or lachesis be given internally. Stimulation and the best nutrition possible should be given.

**TUMORS.** Tumors of the salivary glands are both the connective tissue and epithelial types. Of the former class, fibroma, sarcoma, enchondroma and myxoma occur, and two or three varieties often co-exist in the same tumor. They give rise to nodular enlargement and sometimes contain cystic cavities. A large proportion are of a benign character, may grow to considerable size, and persist for years without causing serious trouble. Carcinoma may develop separately or in connection with sarcoma or enchondroma; it soon extends beyond the limits of the gland.

*Treatment.* As a general thing tumors of the parotid glands are best let alone. The pains that sometimes attend their growth may be mitigated by the use of internal remedies, but that medicine ever reduces or causes the disappearance of these tumors there are few to affirm. The relation of the parotid gland is complicated to an unusual degree by the passage through it of the branches of the facial nerve, the carotid artery and some of its branches. As division of the nerves causes paralysis of some of the facial muscles the removal of the gland when diseased cannot be undertaken with anything like the freedom possible in some other parts. This obstacle precludes the extirpation of most benign growths, and in malignant ones there is added the impossibility of cutting far enough beyond them to offer much safeguard against recurrence.

The sub-maxillary glands are subject to the same disease as the parotid, but are less frequently affected and are less liable to injury. In any cutting operation about them the facial artery is the principal structure liable to injury, and that is easily ligated.

**SALIVARY FISTULA.** This is an unnatural opening from Steno's or Wharton's duct upon the skin or mucous membrane. That from Steno's duct upon the skin is the form most frequently met with. It results from a wound or from perforative ulceration. In its treatment it is first necessary to make sure of an opening within the mouth. If the natural one has become contracted or closed, a seton should be put in until a channel is established. Then the lining of the outer fistula may be touched with



caustic and closure by granulation looked for. If it does not occur a small plastic operation may be employed. (See Surgery of the Digestive System).

**SALIVARY CALCULUS.** Occasionally formed in Steno's or Wharton's duct. Its presence may be ascertained by palpation with one finger in the mouth and one outside, or by a probe passed along the duct, or by a needle thrust through the overlying mucous membrane. If small it may be extracted through the duct, after dilatation. Otherwise an incision may be made over it in the mouth.

**RANULA.** Cysts developing beneath the tongue, near the frenum or between the mylo-hyoid muscle and the mucous membrane, have received this designation. The same term has been applied to distended mucous follicles on the tongue. Of those that occur beneath the tongue some result from obstruction and dilatation of the ducts of the sub-lingual and submaxillary glands and some from distension of mucous follicles. They sometimes attain such size as to prevent closure of the mouth, and thus interfere with deglutition and articulation. They occur mainly in children or young persons of tuberculous or impaired constitutions.

*Treatment.* Cures by medical treatment have been reported, but in common experience, though diseased gums and other morbid conditions of the mouth and the patient's general health may be improved by medical treatment, the cyst persists. Calcarea, thuja, mercury, and the iodides are prominent among the drugs used in this complaint.

Surgical treatment consists of the passage of a large curved needle through the top of the cyst, with the points of entry and exit as far apart as practicable, and then cutting under the needle with scissors so as to make a large opening. After the fluid has escaped, the cavity may be wiped, painted with tincture of iodine, and a strip of gauze (non-toxic) placed in it and renewed daily as long as there is place to put it. Complete excision of the cyst is another method practiced. By either method it is possible to do away with an individual cyst, but new ones are apt to appear. Injections of a few drops of carbolic acid or of a ten per cent. solution of chloride of zinc have been used successfully.

## CHAPTER II.

# THE THYROID GLAND.

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**Definition.**—The thyroid gland usually consists of two lateral lobes connected by an isthmus, with its upper border just below the cricoid cartilage, though variations in form occur. Accessory glandular masses are occasionally present, sometimes as additional lobes and sometimes separated from the main gland, but attached to some neighboring structure.

In structure the gland consists of an outer cortical and an inner medullary substance; the former containing radially disposed gland tubes and follicles; the latter consisting of cells concentrically arranged. It has a generous blood supply and performs an important function in the generation of the blood. Its removal or extensive impairment by disease produces a peculiar cachexia termed myxedema; it is characterized by hebetude, malnutrition, muscular tremor, puffy edema, leucocytosis, and presence of mucin in the blood and connective tissue. Cretinism, a form of idiocy, is supposed to result from defective thyroid action during the period of development.

**Thyroiditis.**—Acute inflammation of the thyroid is rare; it occurs in typhoid fever or other infectious diseases and in glands previously diseased. If an abscess forms it should be opened and treated like abscesses elsewhere.



Fig. 436. Bronchocele—Shears.

Strumitis is inflammation in a gland affected with goitre. Extravasation of blood occurring spontaneously or as a result of traumatism, the formation of thrombi, or tissue-necrosis may serve as exciting cause. In addition to the usual signs of inflammation there may be pressure on the veins of the neck or upon the trachea, causing serious complications. When an abscess has formed the pressure may be relieved by its incision. In other cases a portion of the gland may be removed or tracheotomy performed.

**Goitre, or Bronchocele.**—This is the most common of all abnormalities of the thyroid gland. It is a chronic enlargement, occurring more often in the female sex. It may be congenital, but rarely develops till after the tenth year. It prevails more in certain localities, as in the mountains of Europe and South America. The cause of the disease has not been determined, though

chemical impurities of water and air and the agency of bacteria have been suspected.

The enlargement is caused by over-distention or telangiectatic dilatation of the vessels, by hypertrophy of the gland tissue, by premature or excessive colloid deposit, by increase of fibrous stroma, or by adenomatous growth.

**VASCULAR GOITRE.** This may be congenital or it may develop in later life, when it is not apt to be lasting. Coughing or continued rapid action of the heart seems to produce the condition sometimes. When so produced it usually disappears with its cause. In Grave's, or Basedow's disease the rapid, forcible heart action doubtless causes the thyroid enlargement as well as the protrusion of the eyeballs. The glandular swelling is a secondary consequence of disordered nervous action.

**HYPERTROPHIC GOITRE.** In pure form, it is rare; it may be general or localized, and may be congenital. The enlargement may be due to multiplication of normal cells and follicles or to increase of normal colloid contents. The first form has been designated parenchymatous or granular goitre; the second, colloid or gelatinous goitre.

**Adenoma of the Thyroid.**—An epithelial new growth occurring in the form of isolated nodules or diffused over one or both lobes. It consists of vascular non-typical, gland-like tissue, which persists in this form or is transformed into the likeness of normal gland tissue. Four varieties have been described—the fetal, the gelatinous, the myxomatous and the columnar-celled. (Wolfer.)

**FETAL ADENOMA.** This arises from some remnant of embryonic tissue, though it may not develop till after puberty or pregnancy. It is pale yellow, dark red or reddish brown, according to the degree of vascularity, and occurs in nodes that may attain the size of the fist. Nodes containing numerous cavernous vessels are liable to internal hemorrhages. The glandular follicles in an area of extravasation are frequently distended as a result of constriction and gradually become vesicular cavities. Large hematmata are sometimes transformed into hyaline masses that subsequently become organized and traversed by bands of gland tissue; again, homogeneous cicatricial tissue containing dilated blood vessels is formed.

**GELATINOUS ADENOMA.** Nodular or smooth, occupying the whole gland or a single lobe. Upon section the greater portion of the tumor appears to consist of lumps of colloid substance. The growth starts in the granular cells that lie between the normal follicles. With the multiplication of these cells new follicles form to secrete colloid matter that accumulates, apparently from lack of opportunity to escape. Wolfer distinguishes two kinds of gelatinous adenoma—interacinous and cyst adenoma.

*Interacinous Adenoma.* The largest and commonest form of goitre. The enlargement is due to cysts lined with cubical or spheroidal epithelial cells and filled with colloid substance. The cysts vary in degree of development; in some of the older ones the cavities become filled by multiplication of the lining epithelial cells. Interacinous adenoma may coexist with the fetal form.

*Cyst Adenoma.* Characterized by the formation of cysts of all sizes up to that of a goose egg. The vessels and fibrous tissue between the



cysts become atrophied. In some instances the interacinous cell groups grow and break into the cysts. In other cases small cysts project into the cavities of larger ones, and occasionally these cavities are filled with small cysts. The cystic variety appears to result from fusion of the colloid cavities of the interacinous form. The whole gland may be involved and enormous goitre develop. The intercystic stroma is frequently fibromyxomatous, or consists of hyaline substance resulting from transformation of extravasated blood. Calcification of glandular follicles and vesicles sometimes occurs.

**MYXOMATOUS ADENOMA.** Secondary to the fetal or interacinous forms. The hemorrhagic infiltrations of the latter become transformed into a nearly structureless hyaline substance. Slight efforts at organization appear, and fatty degeneration and calcification of parts of the mass are frequent. If vascularization is more extensive new glandular follicles and tubules may form.

**COLUMNAR-CELLED ADENOMA.** This is very rare. It is characterized by the presence of vesicles lined with tall columnar epithelium.

The above described forms of enlargement do not extend beyond the limits of the thyroid gland, and are benign in character. They do harm by pressure upon the cervical vessels, the trachea, and esophagus. The rings of the trachea sometimes become absorbed so that the canal may be narrowed to an embarrassing degree, or the trachea may be pushed to one side.

In all forms of goitre retrogressive changes are apt to take place and alter the appearance of the growth.

Interstitial hemorrhages are common and may vary from small ecchymoses to large hematmata. These extravasations lead to widespread disintegration and necrosis of tissue, forming foci of brown or yellow softening which ultimately take the form of cysts.

Fatty degeneration of some of the infiltrated goitrous tissue sometimes occurs, giving a creamy appearance to the contents of the softened patch. The tissue enclosing the patch becomes inflamed and an indurated, fibrous cyst wall develops.

A common result of hemorrhage is fibroid degeneration—really a sort of scar formation. Where hemorrhages have been numerous cicatricial bands may permeate the whole tumor, and by contraction cause atrophy of glandular tissue.

Calcareous deposits occur both in the gland tissue and in the new formations. The deposits are most marked where fibrous hyperplasia has occurred, fibrous cyst walls often becoming entirely calcified.

Accumulation of colloid substance is common in goitre. It is secreted by the epithelium, and sometimes by pressure causes absorption of the inter-cystic substance till only their fibrous septa remain. Well developed conditions of this kind have been called multilocular cystomata.

Amyloid degeneration takes place in thyroid glands otherwise normal and in those affected with goitre.

Tuberculosis of the thyroid gland is comparatively rare.

**DIAGNOSIS.** The diagnosis is usually easy. The tumor rises and falls with the larynx in swallowing. The over-lying skin is freely movable and often contains enlarged veins. The tumor is not painful; it enlarges with menstruation and during pregnancy. Observation of these

features with the location and form of the tumor suffice to determine its nature.

**TREATMENT.** Iodine, or some of its compounds, has been the principal remedy used for goitre. Amelioration has many times followed its use, but there have not been many cures. Spongia, natrum carbonicum, calcarea carbonica, staphysagria, phytolacca, and carbonate of ammonia are other drugs that have been used with benefit. Iodine has been employed locally in form of ointment, and in watery solution of the tincture injected into the substance of the gland. A three per cent. ointment of the biniodide of mercury has been applied, and the tumor exposed to the sun or to artificial heat, the treatment being frequently repeated. Electrolysis has been satisfactorily used in some soft tumors.

Surgical operations for goitre have been extirpation of the tumor, ligation of the thyroid arteries, the introduction of setons, puncture or incision of large cysts, and division of the isthmus to relieve pressure on the trachea.

Extirpation, or enucleation, is best done by incising the capsule and shelling out the tumor. Hemorrhage and injury to the recurrent laryngeal nerve are the dangers that attend the operation. The whole gland should not be removed, except for the most urgent reasons, because of the likelihood of producing myxedema. When myxedema has been unavoidably produced it has been found that an artificial supply of animal thyroid gland, substance or extract, relieves the condition. The special tissue-food is introduced hypodermically or through the alimentary canal.

Ligation of thyroid arteries has been practiced with varying success. It has afforded most relief in vascular and parenchymatous forms of tumor. In its performance special care must be observed not to injure the recurrent laryngeal nerve.

Setons have been employed to a considerable extent and with very good results, but the process is so opposed to the current ideas in favor of asepsis, that it is now little resorted to.

Puncture of cysts with trocar and canula and evacuation of contents, or incision, are other methods of securing reduction in size. With the canula corked and retained *in situ* for several days, repeated injections of a twenty-five per cent. solution of perchloride of iron have been made until suppuration converted the cyst into an abscess, to be subsequently treated as other abscesses. Other cysts have been punctured through the one first opened, to limit scar formation. This method is really a modification of the seton practice; it was introduced by Mackenzie.

Division of the isthmus so as to allow the two portions of the gland to separate has sometimes sufficed to relieve the dyspnea. In other cases tracheotomy has been resorted to.

**CARCINOMA AND SARCOMA** sometimes develop in the thyroid gland. Rapid growth, pain, involvement of lymphatic glands and surrounding tissue serve to distinguish them from goitre.

The prognosis is unfavorable, and the treatment is mainly palliative. If diagnosis has been made while the growth is confined to the gland, and while the patient's health is yet good, removal may be considered. It will relieve, for a time at least, pressure-effects, and postpone the fatal termination.

### CHAPTER III.

## TONSILS.

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**General Considerations.**—These gland-like masses contain a large amount of lymphadenoid tissue, and, according to Stohr, lymphoid cells are continually migrating to the free surface. It has been asserted that in the normal condition of the parts numerous phagocytes are present in and about the tonsils and other lymphadenoid tissues of the throat, to consume and destroy bacteria. Whether such is the case or not, it seems pretty certain that morbid, defective conditions of the mucous lining of the throat throw down the barriers of resistance to disease in this region and open the gates of the lymphatic channels to the cervical glands. People with poor tonsils and other defective lymphadenoid tissue in the neighborhood of the fauces are susceptible to colds, tonsillitis, diphtheria and inflammations of the cervical glands. The tonsils are subject to inflammation, hypertrophy, atrophy and new growths.

**Tonsillitis, or Quinsy.**—Certain persons, particularly those of lymphatic temperament, are subject to attacks of acute inflammation of the tonsils and surrounding tissue. That the affection is due to the invasion of germs from without is probably not altogether true. It seems to be a way some people have of becoming “bilious.” Instead of having jaundice, headache, and constipation, as dark-haired people do, they have tonsillitis. Perhaps catching cold and bacterial invasion serve as exciting causes, but a generally perverted functional activity is the predisposing one. Chill followed by high temperature, swelling of the tonsils and adjacent parts, and great pain and tenderness attend the attacks. Pain in the ear is often most distressing. The inflammation begins on one side, but is apt to extend to the other. Whitish deposit in the follicles has given rise to the term follicular tonsillitis. In many cases the inflammation subsides in a few days without suppuration; but abscesses often form, sometimes in the tonsil, more frequently in the neighboring connective tissue. They are generally small, but occasionally extend beneath the wall of an entire side of the pharynx.

**TREATMENT.** Aconite, belladonna, mercurius and hepar sulphur are the main remedies. Very hot applications are usually the best palliatives of the pain. Abscesses should be punctured early with a tenotome.

**Hypertrophy of the Tonsils.**—Common in strumous children, but usually diminishes as they grow older. Chronic catarrhal inflammation or repeated attacks of acute inflammation dispose to it. Enlargement occurs in all degrees. When great, the tumors interfere with respiration and articulation. Sleeping with the mouth open is one of the consequences, and impairment of health is often produced. The chief seat of hyperplasia is the lymphadenoid tissue, which appears more diffused and less markedly aggregated into follicles than normal. (Ziegler.)



**TREATMENT.** Sulphur and baryta carbonica are probably the most effective remedies for chronic enlargement of the tonsils. If the hypertrophy is great excision of a part or of the whole of the tumors should be made. A tonsillotome, scissors, or a probe-pointed bistoury may be used for the purpose. Cocaine anesthesia should be employed, because of the liability of blood getting into the larynx if chloroform be used. If much bleeding occurs it may be temporarily and perhaps, permanently, checked by compression with the finger, or a compress wet with a perchloride of iron solution may be held in place with forceps. Ligation of the carotid may be done as a last resort.

Caseous and calcareous concretions sometimes form in the recesses of the tonsils. They cause irritation and inflammation of the surrounding tissue, bad breath and coated tongue. They should be removed.

**Malignant Growths.**—The tonsils are subject to epithelioma and lympho-sarcoma. As epithelioma usually extends to the tonsils from the tongue or fauces any operation for its removal must be resorted to with reference to the other affected tissues. It occurs more often in men, probably on account of the use of tobacco, breaks down quite rapidly and tends to a fatal termination. Sarcoma causes a more circumscribed and prominent tumor that grows rapidly, suppurates, and causes death usually by hemorrhage. Before it becomes too far advanced it is better adapted for removal than is the epithelial growth.

## SECTION XV. LIGATION OF ARTERIES.

### CHAPTER I. GENERAL OPERATIVE PROCEDURES.

**Primary Considerations.**—Accurate anatomical knowledge is the basis of surgical skill in the successful application of the ligature. Without it the tying of a nerve or the ligating of a tendon is quite apt to lead to disappointing and unexpected results. Familiarity with the whole arterial tree is necessary to the skillful pruning of its branches, and the friendly veins and neighborly nerves must neither be overlooked nor disturbed in their intimate relationship.

The dissecting room is the vestibule of the operating chamber, and anatomy is the only official usher. The surgeon's mind must be capable of reproducing a mental photograph of each region he would assail if he expects to attack it with an unerring knife.

**Instruments.**—Brush and razor, which, with bichloride of mercury, solution 1-1000, will properly cleanse the field of operation, scalpel, dressing forceps, retractors, aneurism needle, an eyed probe, grooved director, tenaculum, tourniquet, sheep-gut or silk ligatures, and a head mirror for deep illumination are needed.

**Operation.**—The operation consists in exposing the artery, opening the sheath, applying the ligature, closing the wound.

The position of the patient is supine for ligation of all arteries except the gluteal, internal pudic, sciatic, and popliteal. The line of the vessel being determined, by observing the well-known landmarks, an incision from two to four inches is made at an angle of five degrees to this line, carefully steadying the integument with thumb and fingers of left hand to prevent "crawling."

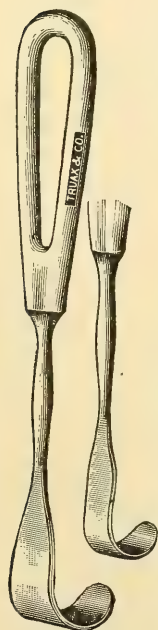


Fig. 437.  
Retractors.



Fig. 438.  
Director.

When the deep fascia is reached, determine the muscular gap to be entered by the eye and finger, moving the extremity if necessary to induce individual muscular action. Incise the deep fascia and interspace to the

extent of the superficial incision; dry-sponge with sterilized gauze; feel for pulsation. The artery feels like a thin rubber tube, the nerve like a hard round cord, the vein like a flat band with raised edges, and compression causes distention. To the eye the arteries are pale pink, nerves white, veins purple.

Venæ comites accompany the arteries of the upper extremities, lower extremities below the knee, smaller arteries of the trunk, and the lingual, lying on either side, before or behind, and communicate across the artery by transverse branches.

Raise the sheath with forceps and cut the transverse fold so as to make a small, longitudinal incision. Introduce the eyed probe, or aneurism needle, unthreaded, with the least possible stripping of artery, then

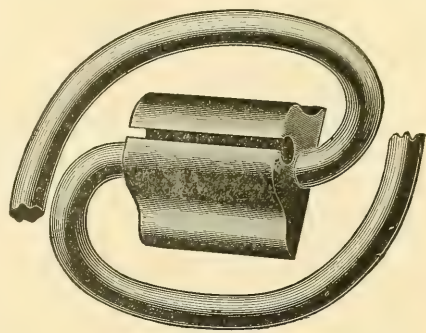


Fig. 439.

**Esmarch's Emergency Tourniquet.**

thread and withdraw. Small venæ comites may be included in the ligature if necessary, large ones must be tied separately and cut if they prevent access to the artery. Should a large vein be wounded apply pressure on the wound for a couple of days, or adjust a lateral ligature.

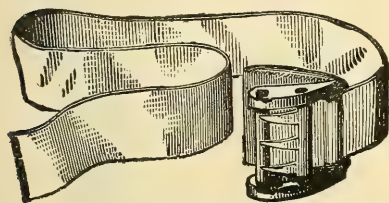


Fig. 440.

**U. S. Army Field Tourniquet.**

Lift the artery ligature and press upon the vessel to determine the absence

of pulsation below; tie at right angles with a reef-knot—sufficiently tight to rupture the internal and middle coats, though this is not absolutely necessary. Too great force may cut entirely through.

Antiseptic ligatures may be cut short, the wound closed with the usual antiseptic precautions and rest secured by either splints, bandage or position.



## CHAPTER II. SPECIAL LIGATIONS.

**Ligation of the Innominate Artery.**—Except for the purpose of ante-mortem dissection and anatomical review the ligation of this great feeder of the right side of the head and neck and the right upper extremity is practically valueless. The success of only two cases in twenty-four is hardly sufficient to justify the operation, and it should not be attempted. This statement is based not so much on the inaccessibility of the vessel, for it is not beyond the reach of the skillful operator, as upon the mortality due to secondary hemorrhage, which depends largely upon the diseased condition of the arterial coats which are antecedent to the aneurism for which the operation has usually been performed.

This artery runs behind the sternum from the arch of the aorta to the right sterno-clavicular articulation, a distance of about one and one-half inches, where it divides into the right common carotid and right subclavian arteries. Extreme extension of the neck renders it slightly more accessible, as the artery is drawn nearer to the upper border of the manubrium.

Operative approach is conducted by making two incisions, one corresponding to the internal border of the sterno-mastoideus, two and a half inches in length, the other three inches along the clavicle, meeting the former incision at the right side of the sternal notch. The reflection of this triangular flap will uncover the lower portion of the sterno-mastoid muscle, and its sternal and clavicular attachments, which should be severed upon a grooved director and made to closely hug their posterior surface lest the subclavian and jugular veins be injured. The anterior jugular veins must be tied and divided as they appear beneath the muscle, obscuring the approach to the sterno-hyoid and sterno-thyroid muscles, which, when cut, disclose the right carotid near its junction with the subclavian. Descending the carotid, the innominate is found flanked by the innominate vein, the pneumogastric nerve and the pleura, and crossed low down by the left innominate vein. The needle should be at once inserted behind the artery, passing from right to left.



Fig. 441.  
Director  
and  
Needle.



Fig. 442.  
Long Aneurism  
Needle.

**Common Carotid Arteries.**—Along the posterior border of that great triangle of the neck bounded by the sterno-cleido-mastoid muscle, the median line, and the lower border of the inferior maxilla and a line



Figure 1. Showing lines of incision for ligation of lingual, common carotid, subclavian and axillary arteries.

Figure 2. Number 1, sterno hyoid muscle cut; 2, sterno thyroid muscle cut; 3, anterior half omohyoid; 4, superior thyroid artery; 5, facial artery; 6, lingual artery; 7, external carotid artery; 8, internal carotid artery; 9, temporo-maxillary artery; 10, internal jugular vein; 11, spinal accessory nerve; 12, cervical plexus; 13, branches of brachial plexus; 14, posterior half of omohyoid muscle; 15, scalenus posticus muscle; 16, splenius muscle; 17, 17, posterior scapular artery; 18, posterior scapular vein; 19, transversalis colli artery; 20, scalenus muscle; 21, vagus nerve; 22, clavicle; 23, subclavian artery; 24, innominate artery; 25, axillary artery; 26, cephalic vein; 27, subclavian artery; 28, transversalis colli artery; 29, ninth nerve; 30, sterno-cleido-mastoid muscle; 31, pectoralis minor.

FIG. 2.

FIG. 1.

FIG. 4.

Figure 3. Showing line of incision for ligation of axillary artery.

Figure 4. Number 1, pectoralis major muscle; 2, pectoralis minor muscle; 3, coraco-brachialis muscle; 4, coracoid head of biceps muscle; 5, axillary artery; 6, subscapular artery; 7, axillary vein, drawn down by a retractor showing the nerves; 8, teres major muscle, 9, tendon of latissimus dorsi muscle.



projected from its angle to the mastoid portion of the temporal bone, lie the common and external carotids. Sweeping up from the lower portion of the neck the graceful omo-hyoid muscle divides into two unequal parts the great anterior triangle and forms the contiguous boundary line of the superior and inferior carotid triangles, the line which separates the triangle of election from the triangle of necessity. We explore the former through choice, the latter only through compulsion. For surgical purposes the right and left carotids extend from the sterno-clavicular articulation to a point corresponding to the thyroid notch, hiding from view, beneath the integument and superficial fascia, the platysma and deep fascia. In the lower portion of its course the three sternal muscles which attach to the mastoid, the thyroid and the hyoid above conspire to conceal the vessel, while the omo-hyoid marks the middle of its course. The descendens noni nerve extends down its sheath and the return current of the blood crosses it through the anterior jugular, the lingual, facial and thyroid veins. The internal jugular vein lies upon its outer side in the same sheath which also includes the pneumogastric nerve as it runs on a posterior plane between the two vessels. A little below the bifurcation of the common carotid the sterno-mastoid branch of the superior thyroid artery crosses on its way to the sterno-mastoid muscle and must be avoided in passing the needle. Passing up from the thyroid axis the inferior thyroid artery runs behind the common carotid on its way to the thyroid gland. Hence we must avoid the descendens noni nerve and sterno-mastoid artery in front of the carotid, the pneumogastric and sympathetic nerve, and inferior thyroid artery behind the carotid, and the internal jugular vein on the outer side of the carotid. The thyroid gland lies to the inner side. One other structure has a dangerous proximity to the posterior surface of the carotid in the lower triangle, and that is the recurrent laryngeal nerve.

**OPERATION.** The vessel is tied, first, above the omo-hyoid; second, below the omo-hyoid.

**First.** Cleanse thoroughly and shave the operative site. Place a sand-pillow under the neck, turn the head midway between shoulder and sternal notch, and elevate the chin. This is the position for both ligations. An incision three inches long, with its middle opposite the cricoid cartilage, made along the anterior edge of the sterno-mastoid, through skin, platysma and fascia, exposes the muscle border. Pressure of the finger point over the external jugular before any incision is made will indicate how to avoid its severance. Cut the deep fascia, retract the sterno-mastoid, draw down the omo-hyoid, recognize the descendens noni on the sheath, open the sheath at its inner side, and pass the needle from without inward. If the vessel lies deeply flexion of the head and depression of the chin will greatly facilitate the exposure of the vessel.

**Second.** A three-inch incision along the line of the artery, extending from the cricoid cartilage nearly to the sterno-clavicular joint, will expose the anterior edge of the sterno-mastoid. The vessel lies deep; separate the sterno-mastoid from the adjacent sternal muscles, and draw the omo-hyoid upward and outward. The distended internal jugular may conceal the artery, especially on the left side. Open the sheath well to the inner side, clean the artery and pass the needle from without inward, hugging the artery closely.

**COLLATERAL CIRCULATION.** The collateral circulation is established through the circle of Willis by means of the two internal carotids, the two vertebrals, through the superior and inferior thyroids of the same side, through the cervical branches of the occipital and superior intercostal of the same side, through the ophthalmic and angular of the same side, through both superior thyroids, both linguals, both facials.

**INDICATIONS FOR OPERATION.** Wounds of the trunk, i. e., cut-throat, gun-shot, punctured wounds—(a) extra-cervical, (b) intra-pharyngeal—secondary hemorrhage, aneurism of the arch, the innominate, the external or internal carotids, the ophthalmic; hemorrhage following operations in throat or mouth, faucial abscess, or carcinoma of tongue or fauces; to restrain or arrest tumor growth—such are the operative indications.

These indications may sometimes be met by ligating the external or internal carotid, or both.

Sir Astley Cooper first successfully ligated the common carotid in 1806.

**External Carotid.**—This artery with its eight branches, the superior thyroid, lingual, facial, occipital, posterior auricular, ascending pharyngeal, internal maxillary, and temporal, supplies the external neck and head. It extends from the bifurcation of the common carotid opposite the superior body of the thyroid cartilage, with a gentle forward curve, upward and backward to a point midway between the condyle of the lower jaw and the external meatus where, embedded in the parotid gland, it divides into its terminal branches. In the lower part of its course it is quite accessible, being covered only by the skin, fasciæ, platysma, and edge of the sterno-mastoid. Passing upward it dips beneath the digastric and stylo-hyoid muscles before entering the parotid. Separating it from the internal carotid are found the glosso-pharyngeal muscle, styloid process and stylo-pharyngeus muscle, while over it passes the hypoglossal nerve with the facial and lingual veins a little below the nerve.

**OPERATION.** A three-inch incision is made along the arterial line from the angle of the jaw to the upper border of the thyroid cartilage. The edge of the sterno-mastoid being retracted and the digastric muscle and hypoglossal nerve being drawn upward and inward, the cornua maxima of the hyoid bone is felt, a little below which the sheath is to be opened and the needle passed from without inward. Should any doubt arise as to whether the vessel uncovered be the external or internal carotid, search for the branches; the internal carotid has no branches in the neck; the ligature is placed preferably between the first and second branches, which should be ligatured at the same time, as also the ascending pharyngeal if accessible; this ensures the establishment of the desired thrombus; close hugging of the artery will protect the superior



Fig. 443. Ward Cousin's Tourniquet.





Figure 1. Number 1, brachial artery; 2, axillary vein; 3, lower portion of brachial artery; 4, axillary artery; 5, subclavius muscle; 6 and 7, large and small ends of pectoralis muscle; 8 and 9, pectoralis minor; 10, ulnar nerve; 11, musculo-spiral; 12, median nerve; 13, circumflex nerve; 15, biceps; 16, coraco-brachialis; 17, axillary plexus of nerves; 18, a branch of same; 19, the musculo-cutaneous; 20, coracoid process; 21, clavicle; 22, serratus magnus; 23, latissimus dorsi; 24, teres major; 25, long head of biceps.

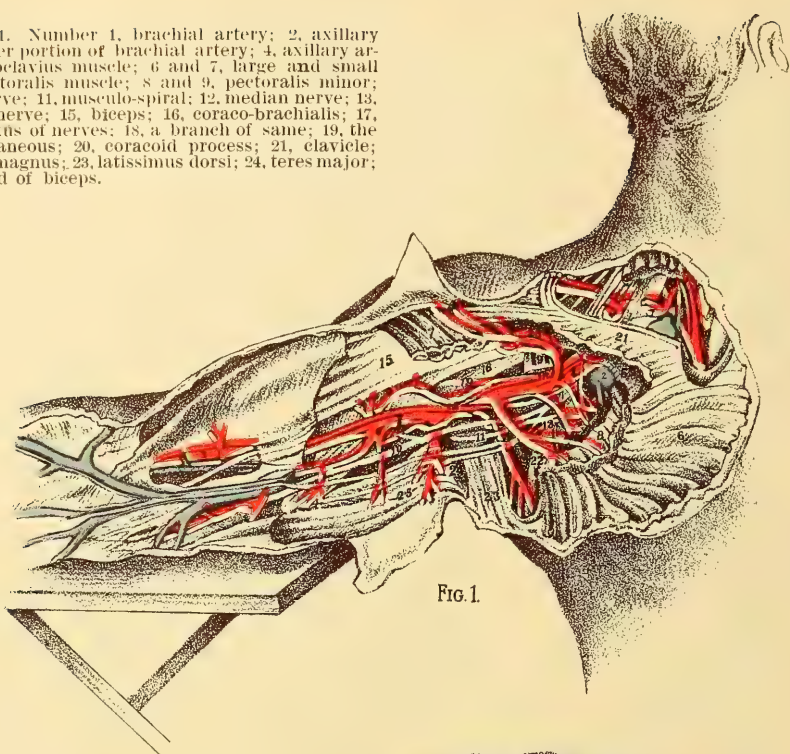


FIG. 1.

Figure 2. Showing the lines of external incision for ligation of facial, temporal and occipital arteries.

Figure 3. Numbers 1 and 2, occipital artery and vein; 3 and 4, temporal artery and vein; 5 and 6, facial artery and vein.

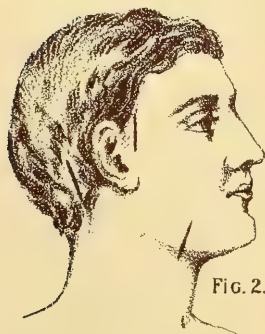


FIG. 2.



FIG. 3.

laryngeal nerve, which lies behind the artery, and the intimately associated internal jugular and internal carotid will escape injury, as well as the descendens noni. Should a high ligation be desired from some exceptional reason a higher incision will uncover the stylo-hyoid and digastric muscles, which must be drawn downward and partially severed if necessary, the stylo-mastoid, which must be drawn outward, and the parotid gland, which must be drawn upward. Do not include the internal and external carotid in the same ligature.

**INDICATIONS.** Wounds of artery or of its branches. Cirroid tumor of scalp. Anticipatory measure to severe operations about the head.

**Internal Carotid.**—This vessel, having a common origin with the external carotid, passes upward behind, a little external to the external carotid, and enters the cranium through the carotid canal. This artery is tied only near its origin.

**OPERATION.** The incision should be made about one-half inch external to the site of the incision for ligating the external carotid. The first inch is the only accessible location for a ligature, the sterno-mastoid is drawn outward, the external carotid drawn inward, the needle passed from without inward, avoiding the internal jugular and pneumogastric nerve.

**INDICATIONS.** Wounds and aneurism.

**Superior Thyroid.**—This vessel comes off from the external carotid just below the great cornu of the hyoid bone, and is the first branch to leave that vessel. From its superficial location it is frequently injured in cut-throat, in which case it is ligated in the self-inflicted wound, which may be enlarged if necessary for the proper exposure of the vessel. Formal ligation is sometimes employed in the treatment of bronchocele, or as preparatory to removal of the thyroid gland. The vessel passes upward and forward, and arches sharply downward to reach the thyroid gland.

**OPERATION.** Make a two-inch incision parallel with the sterno-mastoid, with its central point opposite the thyroid notch. This incision should be slightly anterior to the one made to reach the external carotid. The sterno-mastoid being retracted the artery is readily discovered; crossing veins may have to be tied and divided.

**Lingual Artery.**—Except where this artery arises from a common trunk with the superior thyroid, or a common trunk with the facial, it has an independent origin between the superior thyroid and facial at a point opposite the hyoid cornu. Passing beneath the stylo-hyoid, and posterior belly of the digastric, it dips beneath the hyoglossus, under which it runs parallel with the great cornu, then ascends perpendicularly to the under surface of the tongue, terminating in the ranine artery.

**OPERATION.** This vessel may be tied either before or after its passage beneath the digastric.

**First.** A two-inch incision starting at the margin of the sterno-mastoid runs forward, curving slightly upward just above the great cornu. Guard the facial vein near the beginning of the incision which cuts through the skin, fascia and platysma. The submaxillary gland is brought to view, overlapping the digastric. Cut the deep fascia, raise the gland, hook down and steady the great cornu, and define the posterior margin of the digastric. Clean the angle between the hyoid bone and the

digastric and push up the hypoglossal nerve which lies upon the hyoglossus muscle and marks the location of the artery, running at a slightly lower level behind the muscle. Cut the posterior fibres of the muscle either upon a director or by successive cuts from without inward, and the artery will be found a little above the bone.

**Second.**—Between the digastric bellies. Cut through the same superficial structures as above with a crescentic incision extending from a point over the hyoid one-half inch from the median line, along the body of the bone, curving upward at the cornu and terminating below the infra-maxillary angle. Turn up the flap; raise the submaxillary gland; define the hypoglossal nerve and the two bellies of the digastric; remove the fat and uncover the hyoglossus muscle; divide its fibres, when the artery accompanied by one or two veins will be found. Pass the needle from above downward.

**Facial Artery.**—This artery is very superficial where it passes over the border of the jaw just in front of the masseter muscle. Draw the integument well up so that when relaxed the incision will fall below the margin of the jaw; make a short transverse incision through skin, platysma and fascia. To avoid the vein pass the needle from behind forward.

**Temporal Artery.**—Make a short vertical incision in front of the tragus at the root of the zygoma. This artery is readily controlled by pressure. When accident would require incision of the parotid gland to reach this vessel or the internal maxillary ligate the external carotid above the facial.

**Occipital Artery.**—This can be ligated at its origin opposite the facial through an incision in the carotid line, the center of which is one-half inch above the tip of the great cornu of the hyoid. Avoid the hypoglossal nerve which lies upon the external carotid and winds beneath the occipital.

This artery can be ligated also behind the mastoid process where the artery sweeps upward and backward to its final distribution. An incision over the course of the artery about one-half inch behind the mastoid will uncover the vessel beneath the aponeurosis of the sterno-mastoid muscle.

**Posterior Auricular.**—Its relations with the parotid gland, facial and spinal accessory nerves require the ligation of the external carotid above the occipital when the circulation through the posterior auricular must be interrupted.

**Ascending Pharyngeal.**—This, the smallest branch of the external carotid, passes upward from its origin near or opposite the facial, between the two carotids, crossed by the stylo-pharyngeus muscle. It may be exposed opposite the hyoid bone by an incision in the carotid line.

**Subclavian Artery.**—Upon the right side of the artery this has its origin, in conjunction with the carotid, from the innominate. Upon the left side it springs directly from the aortic arch. For surgical reference each subclavian is divided into three portions, the first extending from the origin of the vessel to the inner border of the anterior scalenus muscle. The second lies behind that muscle. The third

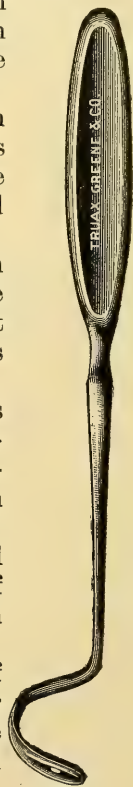


Fig. 444.

Helical Artery Needle.





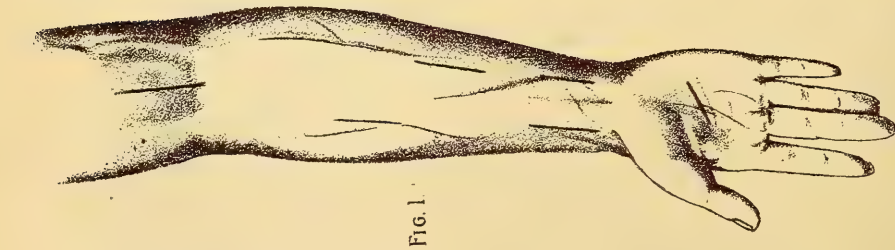


Fig. 1.

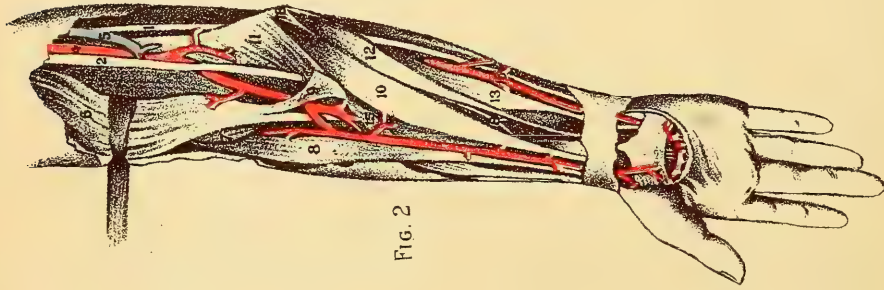


Fig. 2

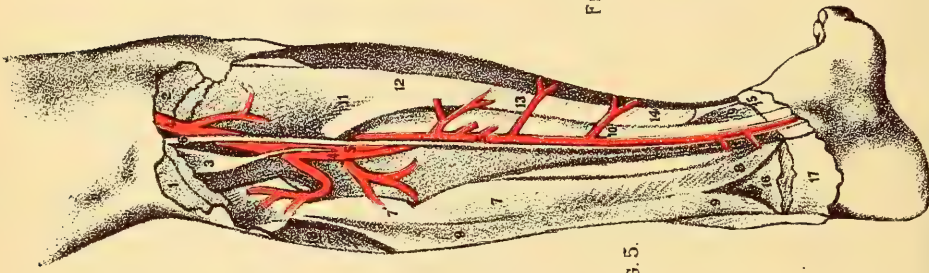


Fig. 5.



Fig. 3.

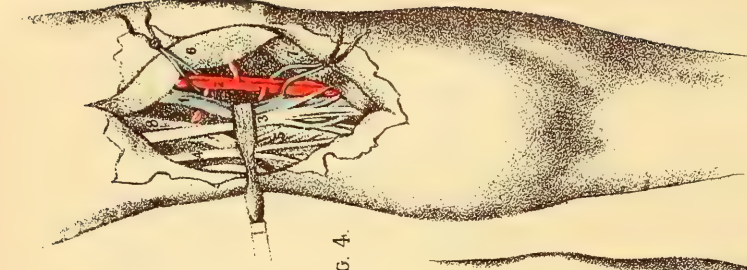


Fig. 4.

Figure 1. Showing lines of incision for ligation of brachial, radial and ulnar arteries. Number 1, ulnar nerve; 2, median nerve; 3, median nerve; 4, brachial artery; 5, ulnar artery; 6, biceps muscle drawn aside with a retractor; 7, supinator muscle; 8, supinator radii longus; 9, aponeurosis of tendon of biceps, partially cut off; 10, flexor carpi radialis; 11, fascia; 12, palmaris longus; 13, flexor sublimis digitorum; 14, superficial palmar arch; 15, pronator radii teres; 16, ulnar artery; 17, radial artery; 18, olecranon process.

Figure 5. Number 1, 2, the two heads of gastrocnemius; 3, plantaris muscle; 4, popliteal artery; 5, posterior tibial artery; 6, middle branch of sciatic nerve; 7, 7, the fibula; 8, tendon of flexor longus pollicis; 9, 9, peroneus brevis muscle; 10, tendon of flexor communis digitorum; 11, popliteus muscle; 12, 13, 14, the tibia; 15, internal annular ligament; 16, the astragalus; 17, tendon of fibula; 18, posterior tibial artery; 19, tendon of fibula; 20, posterior tibial artery.

Figure 3. Showing line of incision for ligation of popliteal artery. Number 1, popliteal vein drawn outward; 2, popliteal nerve; 3, middle branch of sciatic nerve; 4, external popliteal nerve; 5 and 7, heads of gastrocnemius; 6, semimembranosus muscle; 8, biceps muscle.

extends from the outer border of the muscle to the lower border of the first rib. Many important branches arise from the subclavian.

From its first portion, the vertebral, the thyroid axis with its inferior thyroid, transversalis colli, and supra-scapular branches, the internal mammary. From its second portion, the superior intercostal.

**FIRST PORTION.** A uniform fatality in eighteen ligations of the first portion practically removes this portion from the operative field, and a successful result in only four cases out of thirteen ligations of the second portion furnishes small encouragement for more than a possible success in this portion. Even the ligation of the third portion is attended by a large mortality, which is due mainly to the serious conditions which demand its performance. The anatomical difficulties of ligating this division are so much fewer than those pertaining to the first, or even the second portion, that it is pre-eminently the region of election. It lies in the subclavian triangle bounded by the omo-hyoid above, the sterno-mastoid in front, the clavicle below. It lies on the scalenus medius with the subclavian vein below and the brachial plexus of veins at its outer side. Crossing in front of the vessel are the supra-scapular, transversalis colli arteries and veins, and branches of the cervical plexus of nerves; near the border of the scalenus anticus it is crossed by the external jugular vein. On the inner border and upper surface of the first rib is found a tubercle which gives attachment to the anterior scalenus, which, lying with the subclavian artery on its outer side and the subclavian vein on its inner side, serves as an operative landmark, either for compression or ligation of the artery.

**SECOND PORTION.** If compelled to invade this territory remember that the artery lies behind the scalenus anticus, the outer border of which is carefully cut through an incision made as above, and the needle passed from above downward.

**THIRD PORTION.** Patient is to lie on dorsum with shoulders raised and head turned to the opposite side. The clavicle is depressed by drawing the arm down. As the vessel is generally one-half inch above the clavicle, draw the integument down one-half inch on to the bone. Outline the external jugular vein by finger-pressure. Make an incision along the bone between the adjacent borders of the trapezius and sterno-mastoid. This severs the skin, superficial fascia and platysma and some superficial veins and nerves. Relax the integument, when the incision will correspond to the location of the artery. Cut through the deep fascia, draw the external jugular to the outer extremity of incision. If compelled to cut the vein do so between two ligatures. The tense edge of the scalenus anticus is the most reliable guide to the location of the artery; carefully break up the loose cellular tissue and omo-hyoid aponeurosis. Guard the transversalis colli. Run the finger down the scalenus till the tubercle or rib is reached, when the artery will be felt beating on the outer side. Clear the artery and define the nearest cord of the brachial plexus. Protect the vein with the finger, remembering the proximity of the pleura, and introduce the needle from the nerve side to the vein side. Look out for an errant phrenic nerve before tightening the ligature.

**COLLATERAL CIRCULATION.** The supra-scapular and transversalis colli from the thyroid axis inosculate with the subscapular, and its dorsalis scapulæ, from the axilla.



**Vertebral Artery.**—This vessel passes directly upward from its origin in the first portion of the subclavian to reach the foramen in the transverse process of the sixth cervical vertebra, finally reaching the brain through the foramen magnum. At the point of ligation it lies in a groove between the longus colli and scalenus anticus muscles. This point is below the sixth cervical transverse process which forms the guide to the artery. In front of the artery is found the internal jugular, inferior thyroid, thoracic duct (left side), vertebral vein and sympathetic plexus.

**OPERATION.** An incision from three to four inches long is made along the outer border of the sterno-mastoid, reaching nearly to the clavicle; avoid the external jugular, draw it with the sterno-mastoid well inward; the border of the scalenus anticus must be defined and the groove between this muscle and the longus colli carefully opened through the deep connective tissue with a director. Protecting the phrenic nerve and transversalis colli artery, lying on the scalenus anticus, the internal jugular, the thoracic duct, and the vertebral vein, by drawing these structures aside with hooks, the needle is passed from without inward. Illumination of the deep wound necessary for the exposure of the vessel can be made by a head mirror. Great care must be taken not to injure the sympathetic plexus lying in front of the vessel.

Ligation of this artery for epilepsy has proven so futile that the operation is now restricted to wounds of the vessel and aneurism.

**Inferior Thyroid.**—Necessity for this ligation except for a wound is very rare; coming off from the thyroid axis and passing behind the internal jugular and carotid it can be reached through an incision similar to that for tying the carotid, drawing the carotid and vein well outward and tracing the small branches of the inferior thyroid to the trunk.

**Internal Mammary.**—This vessel also arises from the first portion of the subclavian and, passing downward under the clavicle and externally to the pleura, rests on the costal cartilages not far from the outer border of the sternum. It forms an important anastomosis by its terminal branch, the superior epigastric, with the deep epigastric of the external iliac.

It can readily be tied in the first three intercostal spaces by making an incision two inches long, one-half inch externally to the edge of the sternum, dividing the pectoralis major and intercostal muscles. Care is required not to penetrate the cavity of the pleura when isolating the artery from its veins.

**Axillary Artery.**—This artery, the continuation of the subclavian, extends from the lower border of the first rib to the lower border of the latissimus dorsi and teres major muscles, where it assumes the name of brachial. Like the subclavian it has three anatomical portions, that above the pectoralis minor being the first, while the second is behind, and the third is below that muscle. Its surgical portions are two: that of necessity, the first portion; and that of choice, the third portion.

The first portion is covered by the clavicle, the pectoralis major and subclavian muscles, the costo-coracoid membrane and the cephalic vein; and flanked on the outer side by the brachial plexus, and the inner side by the axillary vein. Its approach is more difficult than the third portion of the subclavian, ligation of which is preferred by some operators. The



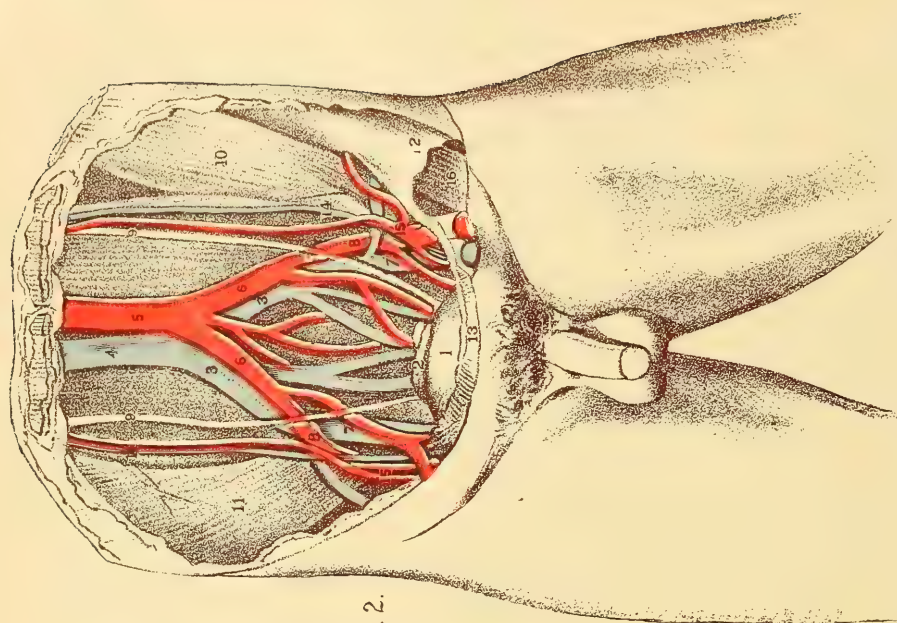


FIG. 2.

Figure 2. Number 1, bladder; 2, rectum; 3, 3, right and left common iliac veins; 4, vena cava; 5, aorta; 6, 6, common iliac arteries; 7, 7, right and left external iliac arteries; 8, 8, right and left internal iliac arteries; 9, 9, right and left internal iliac arteries; 10, 10, right and left iliac muscles; 12, anterior superior iliac spine; 13, symphysis pubis; 14, 14, spermatic veins; 15, 15, spermatic arteries; 16, spermatic artery.

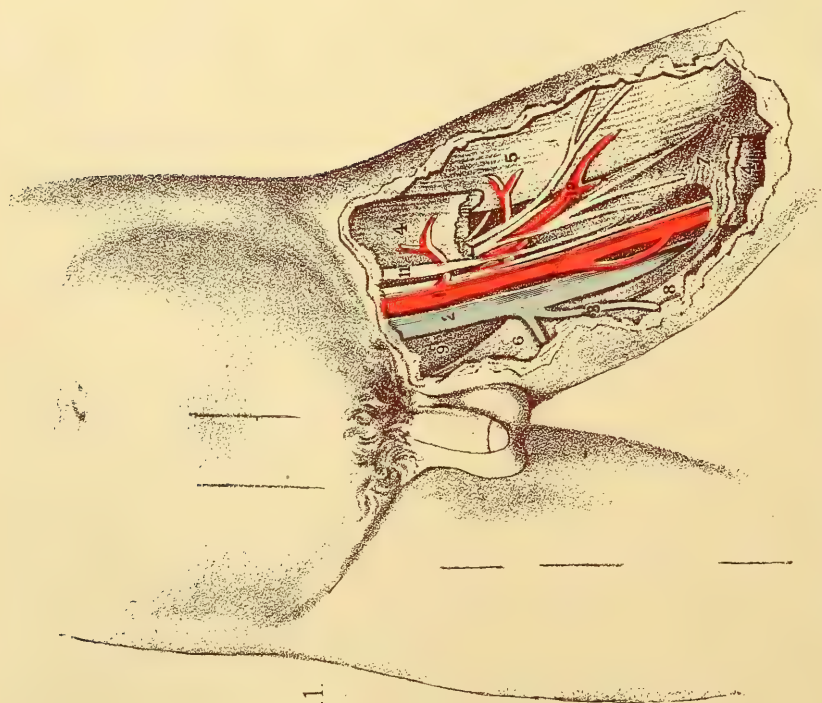


FIG. 1.

Figure 1. Number 1, femoral artery; 2, femoral vein; 3, sartorius muscle; 4, 4, vastus externus; 5, vastus internus; 6, adductor longus muscle; 7, 7, gracilis muscle; 8, gracilis muscle; 9, pectineus muscle; 10, profundus femoris artery; 11, femoral nerve. Upon the right side are seen the lines of incision for the ligation of the femoral and iliac arteries.



third portion in its lower part is covered by integument and fascia, in its upper part by the pectoralis major. On the outer side are the coraco-brachialis, the median and musculo-cutaneous nerves. On the inner side lie the ulnar and internal cutaneous nerves, and the axillary vein. Behind are the subscapularis, the tendons of the latissimus dorsi and teres major, and the musculo-spiral and circumflex nerves. In the upper part of this portion the median nerve lies immediately upon the artery, then passes to the outer side.

**LIGATION OF THE FIRST PORTION.** The incision, slightly curved, should extend downward, one-half inch below the clavicle, from near the sterno-clavicular joint to just outside the coracoid process. Cut lightly through the skin, platysma and deep fascia, carefully guarding the cephalic vein and acromio-thoracic artery. Incise the clavicular attachment of the great pectoral muscle the whole extent of the wound, find the upper border of the pectoralis minor and draw it downward. Tear through the costo-clavicular membrane close to the coracoid process which, with the small pectoralis, forms one of two reliable guides to the artery. Feel for the pulsating vessel internally to the brachial plexus, clear the artery, draw the axillary vein inward and pass the needle from within outward. Adducting the arm by relaxing the parts will facilitate the last steps of the operation.

**LIGATION OF THE THIRD PORTION.** Place the arm at right angle to the body. Make a three-inch incision through the junction of the anterior and middle thirds of the axilla along the inner border of the coraco-brachialis muscle, draw the muscle and the median nerve outward, the internal cutaneous nerve and axillary vein inward, clear the artery and pass the ligature from within outward some distance below the circumflex branches.

**Brachial Artery.**—This artery extends from the axillary, of which it is the continuation, to one-half inch below the bend of the elbow, where it bifurcates and forms the radial and ulnar. From beginning to termination it is practically superficial, lying along the inner border of the coraco-brachialis and biceps, crossed by the median nerve at a very acute angle in the middle of its course, and near its termination by the bicipital fascia and median basilic vein. In the upper third the ulnar nerve and basilic vein lie on its inner side, but in the lower third are well removed. On either side are the venæ comites, in the lower half of its course, with here and there a communicating branch. The basilic vein lies upon the deep fascia until it reaches the upper third, where it pierces it on its way to the axillary vein.

**OPERATION.** The point of election is the middle third. A line drawn from the union of the middle and anterior thirds of the outer wall of the axillary space to the middle of the elbow will overlies the vessel. Make a three-inch incision dividing the skin and deep fascia. The median nerve is readily seen crossing from the outer to the inner side of the vessel. Pass the ligature from the inner to the outer side, guarding the basilic vein and venæ comites and the nerve. These directions will apply to a ligation in the upper part of the vessel.

**AT THE BEND OF THE ELBOW.** When necessary, which is seldom, make a two-inch incision parallel with the inner edge of the biceps tendon, guarding the median basilic vein, drawing it inward; clear out the fat; expose

the artery, and protect the median nerve by passing the needle from the inner side.

**Radial Artery.**—This, the continuation of the brachial, lies between the belly and tendon of the supinator longus on the outer side and the pronator radii teres and the flexor carpi radialis on the inner side. A line drawn from the middle of the elbow to the styloid process of the radius marks the course of the artery, which is readily exposed either above or below through an incision which at the wrist extends only through the deep fascia and above through the intermuscular septum. The radial nerve, always upon the outer side, is near the artery only in its middle third.

**Ulnar Artery.**—This artery begins at the bifurcation of the brachial, one-half inch below the bend of the elbow, passes outward and downward beneath the radial pronator and flexor muscles, to reach the radial border of the flexor carpi ulnaris about the middle of the forearm, along which it continues to the annular ligament which it crosses to become the superficial palmar arch.

**OPERATION.**—*At the Bend of the Elbow.* An extension of the incision for ligating the brachial at this location will uncover the bifurcation, where the ulnar may be tied near its origin.

*Ligation in the Lower Third.* Make an incision along the radial border of the ulnar flexor, terminating at least one inch above the pisiform bone. The pulsation of the artery furnishes a guide for the incision. The ulnar nerve lies to the inner side; the palmar cutaneous branch overlies the artery and must be avoided by drawing it inward and passing the needle from within outward. The superior palmar arch from the ulnar and the deep palmar arch from the radial, if wounded, can be ligated in the wound, tying both divided ends.

**Intercostal Arteries.**—From the angle of the rib forward an intercostal artery lies between the two planes of intercostal muscles near the lower border of the rib, with the vein above and the nerve below.

**OPERATION.** An incision through the external intercostal muscle will ordinarily render the artery visible. If it cannot be secured in this way a ligature can be passed beneath the rib and tied over a piece of rubber tubing laid upon the skin over the rib between the ends of the ligature.

**Abdominal Aorta.**—A uniform fatality having attended this ligation in ten operations, it is to be regarded as pre-eminently a dissecting-room procedure. The bifurcation of the aorta is upon the left side of the fourth lumbar vertebra, a point crossed by a line drawn on a level with the highest part of the iliac crests.

**OPERATION.** The vessel can be reached through (a) a median incision; (b) through a lateral incision.

(a) Open the peritoneal cavity through the linea alba by a five-inch incision, whose center presses to the left of the umbilicus. Raise the transverse colon, separate the small intestines, scratch through the mesentery with a blunt finger nail and expose the aorta; pass the ligature from right to left.

(b) The approach to the vessel is retro-peritoneal. Make a curved incision from the extremity of the eleventh rib downward and inward three-fourths of an inch inside the anterior superior iliac spine, to a point three-fourths of an inch above the middle of Poupart's ligament. Cut to





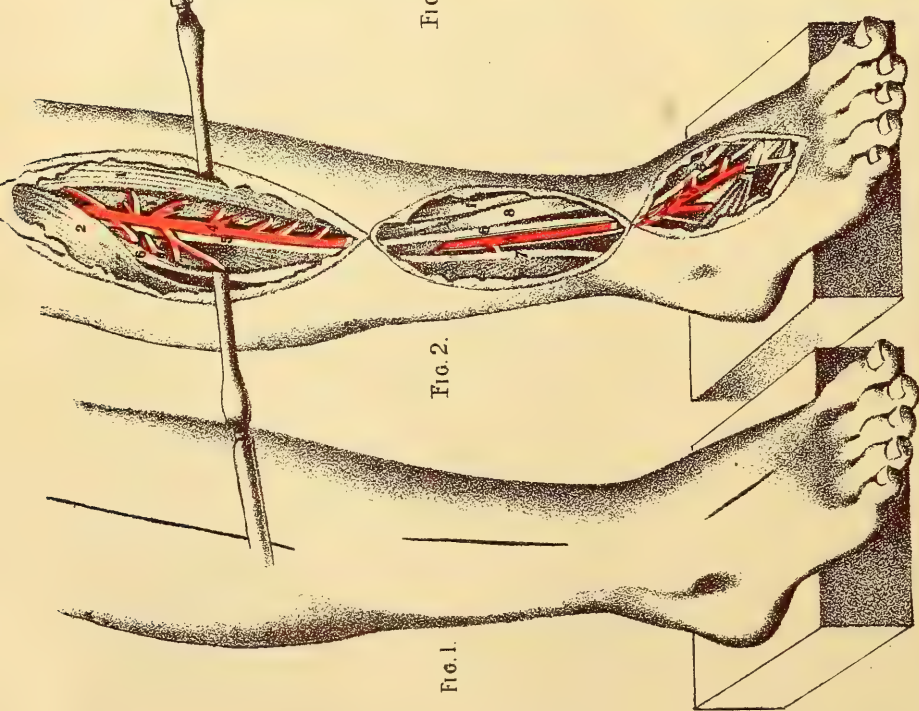


FIG. 1.

FIG. 2.

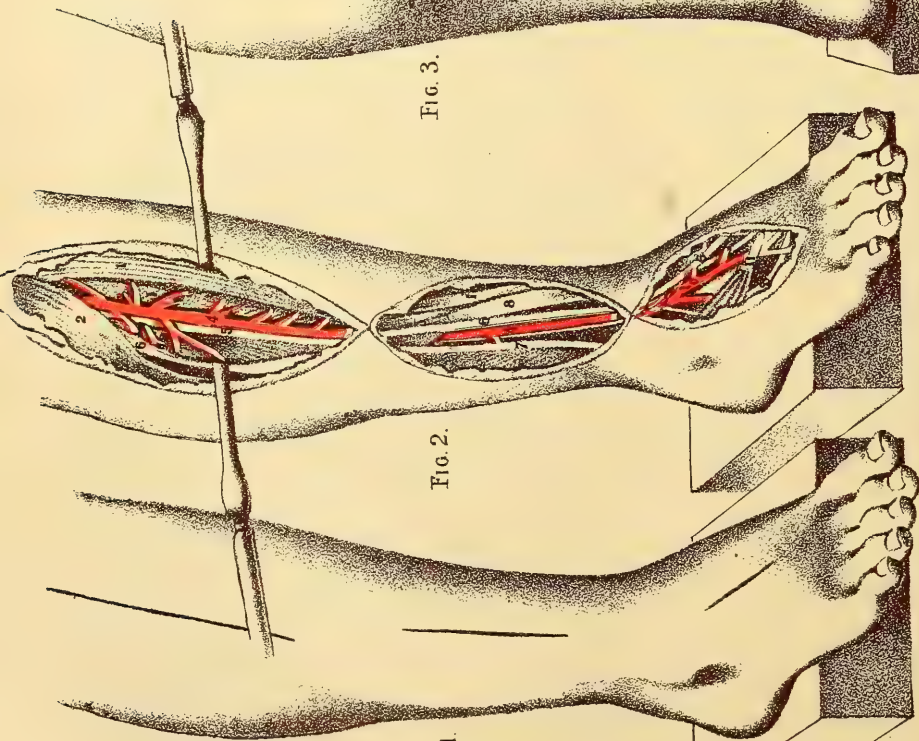


FIG. 3.

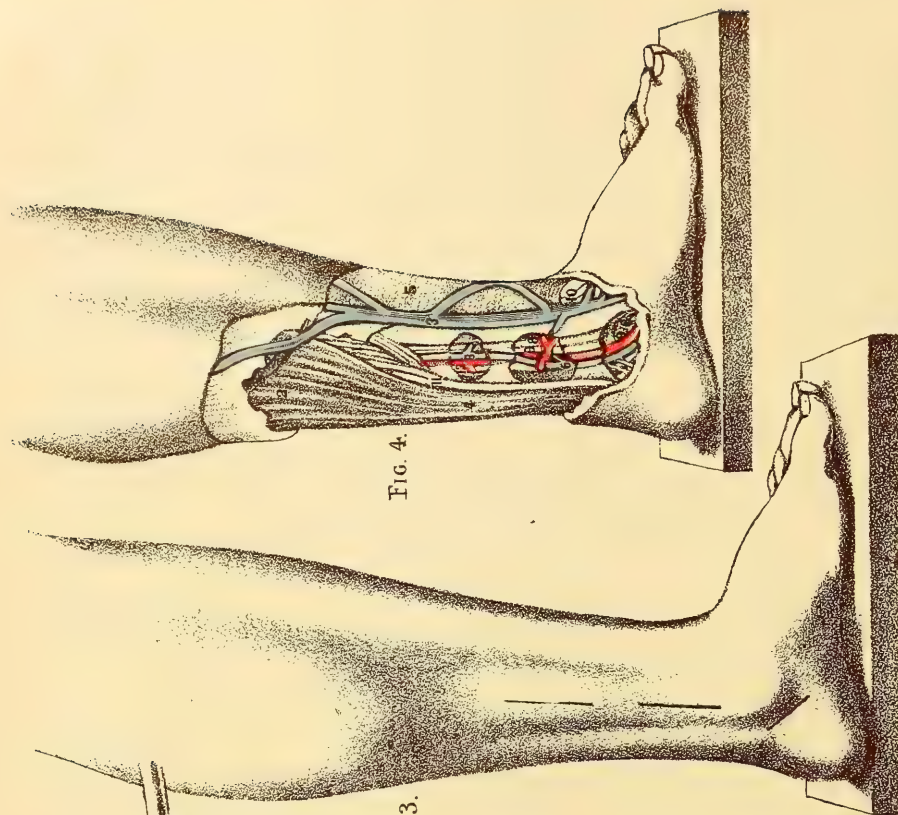


FIG. 4.

Figure 1. Showing lines of incision for ligature of anterior tibial and dorsalis pedis arteries.  
 Figure 2. Number 1, 1, 1, the tibialis anticus muscle and tendon; 2, extensor longus digitorum; 3, extensor longus pollicis; 4, 4, anterior tibial artery; 5, anterior tibial nerve; 6, 6, 6, tendon of the extensor longus pollicis; 7, tendon of the extensor longus digitorum muscle; 8, the tibia; 9, tendon of the extensor longus digitorum; 10, dorsalis pedis artery; 11, tendon of the extensor brevis digitorum.

Figure 3. Showing lines of cutaneous incision for the ligature of posterior tibial artery.  
 Figure 4. Number 1, soleus muscle; 2, gastrocnemius; 3, long saphena vein; 4, tendo-Achillis; 5, the tibia; 6, 6, the venae comites; 7, posterior tibial artery; 8, tendon of the tibialis posticus muscle; 9, tendon of the flexor longus digitorum; 10, tendon of the tibialis anticus; 11, the plantaris muscle; 12, the posterior tibial nerve.

the peritoneum—not through it; strip the peritoneum from the posterior abdominal wall and psoas muscle, avoiding the ureter and lumbar nerves; isolate the aorta from the sympathetic branches and vena cava and pass the needle from right to left. The median method is preferable.

**Iliacs.**—The course of the common and external iliac arteries is covered by a line drawn from a point one-half an inch below and to the left of the umbilicus to the middle of Poupart's ligament. The upper third of this line corresponds to the common iliac, the remainder of the line to the external iliac. The common iliacs extend from the bifurcation of the aorta to the right and left sacro-iliac articulations, where they divide into the external and internal iliacs. They are covered by the peritoneum and are crossed by the ureters—in women by the ovarian arteries. The ilium, branches of the superior mesenteric artery and sympathetic nerve lie in front of the right common iliac; the sigmoid flexure and branches of the inferior mesentery artery lie over the left common iliac.

The right common iliac vein lies first behind, then to the outer side of its corresponding artery; the left vein lies to the inner side of its artery, then crosses behind the right artery. The external iliac, with the vein on the inner side, runs on the inner border of the psoas muscle, from its origin to Poupart's ligament, where it becomes the femoral. It lies behind the ilium on the right and the sigmoid flexure upon the left, while on both sides it is crossed by the spermatic vessels and vas deferens in men, the ovarian vessels in women, a branch of the genito-crural nerve and sometimes the ureter.

**OPERATION.** All the iliacs are preferably ligated through an incision in the linea alba, or at the outer border of the recti muscle. Hold the intestines back with gauze or draw them out of the wound and protect them with rubber cloth and warm towels. Open the posterior peritoneum by two dressing forceps or blunt director, isolate the vessel and pass the needle from right to left for the common iliacs and from within outward for the external iliacs.

The external and internal iliacs may be ligated behind the peritoneum through an incision starting one inch above and internal to the anterior superior iliac spine, and describing a gentle curve to a point just outside of the external abdominal ring. Cut through the muscles and transversalis fascia to the peritoneum, which is to be separated carefully from the iliac fossa until the artery is reached, going to the bifurcation if the internal artery is sought. Pass the needle from the inner side.

**Gluteal Artery.**—This artery comes out of the pelvis between the upper border of the pyriformis muscle and the upper margin of the great sacro-ischiatic foramen.

**OPERATION.** Make an incision five inches long on a line drawn from the posterior superior iliac spine to the apex of the great trochanter. When the gluteus maximus is reached separate its fibres with the handle of the scalpel. Feel for the border of the notch and the pulsation of the artery will be felt as it curls up over the bony margin. Retract the muscles well, isolate the artery and pass the needle in either direction.

**Sciatic and Internal Pudic.**—These vessels emerge through the foramen below the pyriformis. The sciatic lies nearest the trochanter, and closely associate with the great and lesser sciatic nerves.

**OPERATION.** The incision is made on a line extending from the



middle of the sacral spines to the trochanter apex. Feel for the lower border of the pyriformis and the pulsation of the artery. The internal pudic lies one-half inch nearer the sacrum. For these three ligations the patient lies prone with the femur rotated towards the sacrum.

The internal pudic can be reached in the perineum by placing the patient in the lithotomy position. Make an incision on a line drawn from the symphysis pubes to the inner side of the tuberosity of the ischium. The vessel will be found accompanied by the vein and the internal pudic nerve, about one inch and a half above the tuberosity, skirting the ramus of the ischium.

**Epigastric Artery.**—This vessel is given off from the external iliac just above Poupart's ligament and runs upward and inward toward the umbilicus between the peritoneum and transversalis fascia.

**OPERATION.** Make a three-inch incision one-half inch above and parallel with the ligament with its center opposite the middle of the ligament. Divide the muscles down to the transversalis fascia. Tear through the fascia and the vessel will be exposed near its origin. The circumflex iliac and external iliac may be tied through the same incision.

**Femoral Artery.**—This artery, the continuation of the external iliac, extends from the middle of Poupart's ligament down the front and inner part of the thigh till it passes through the opening in the adductor magnus, to be continued down the back of the thigh under the name of the popliteus. The upper third of the artery, lying in Scarpa's triangle, is very superficial. At its origin the femoral vein lies close to its inner side, and on its outer side from a quarter to a half inch lies the anterior crural nerve. The profunda femoris is given off one inch and a half below the ligament from the outer side of the artery. The vein passes gradually behind the artery till at its termination it lies external to the artery. Over the middle third of the vessel lies the long saphenous nerve.

A line drawn from the middle of Poupart's ligament to the adductor tubercle on the inner condyle of the femur will mark the course of the vessel. It may be ligated in (a) Scarpa's triangle, or (b) Hunter's canal.

**OPERATION.** (a) Make an incision three inches long in the line of the artery, beginning two inches and a half below Poupart's ligament. Find the sartorius beneath the fascia lata and draw it outward; should the saphenous vein appear draw it inward. Open the common sheath of the artery and its vein; open the special sheath of the artery, and pass the needle between the vein and artery.

(b) Make a four-inch incision in the middle third of the thigh, parallel with, but somewhat internal to the arterial line; uncover the sartorius and draw it outward. The roof of Hunter's canal will then be seen. Cut through this aponeurosis, guard the long saphenous nerve, which lies upon the sheath of the artery, open the sheath and pass the needle between the vein and artery, i.e., from without inward.

The common femoral is rarely tied, but both it and the profunda femoris are reached by an incision through the center of Scarpa's triangle reaching beneath the fascia lata. Search for the profunda along the outer aspect of the common trunk.

**Popliteal Artery.**—This vessel passes downward and outward





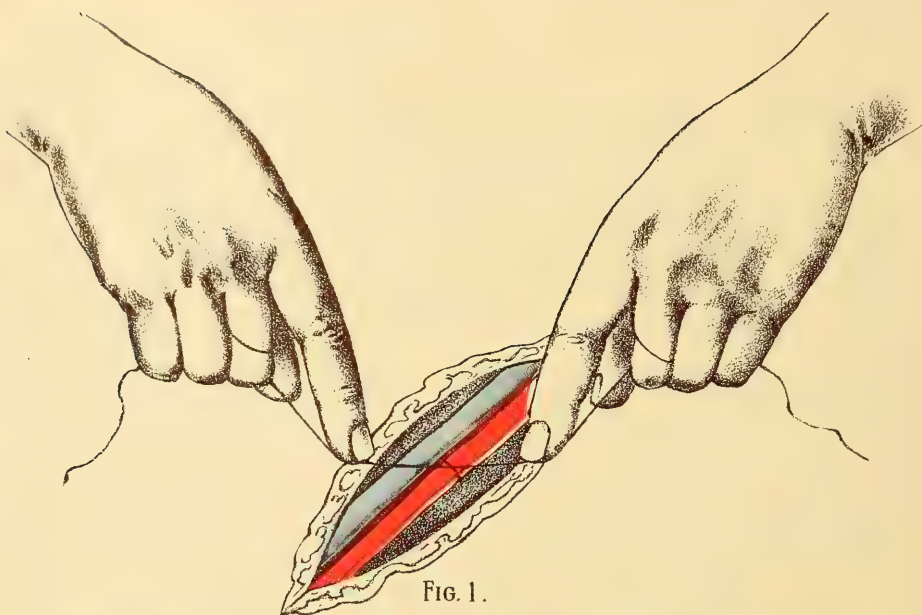


FIG. 1.

Figure 1. Ligating an artery in continuity; manner of tightening the ligature.

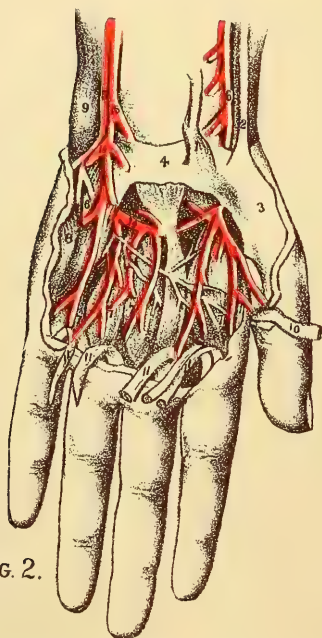


FIG. 2.

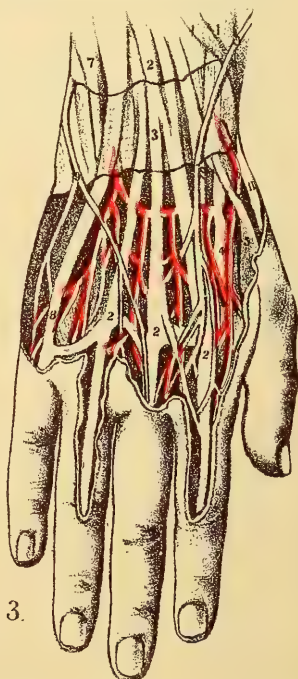


FIG. 3.

Figure 2. Number 1, tendon of extensor carpi radialis; 2, extensor tendon of the thumb; 3, carpal end of the metacarpal portion of thumb; 4, annular ligament; 5, ulnar nerve; 6, flexor brevis minimi digiti; 7, palmar interossei; 8, abductor minimi digiti; 9, pisiform bones; 10, tendon of flexor longus pollicis; 11, tendons of flexor sublimis digitorum profundus, with lumbricales; 12, artery of the thumb; 13 and 14, deep palmar arch; 15, ulnar artery; 16, radial artery.

Figure 3. Number 1, extensor tendon of the thumb; 2, 2, 2, 2, tendons of extensor communis digitorum; 3, annular ligament; 4, tendon of extensor carpi radialis longior; 5, tendon of third extensor of thumb; 6, radial artery; 7 and 8, tendons of extensor minimi digiti; 9, dorsal branch of ulnar nerve; 10, tendon of extensor carpi radialis longior; 11, tendon of extensor of thumb; 12, radial nerve.

through the popliteal space from the termination of the femoral to the lower border of the popliteus muscle, where it divides into the anterior and posterior tibials. It is seldom ligated except for a wound, and only then in its upper or lower portion. Above the joint the popliteal vein lies superficial and external to the artery, and the nerve is still more superficial and external. Below the joint the nerve and vein cross the artery and lie on the inner side.

**OPERATION.** The patient lies prone with leg extended. Make a three-inch incision along the outer edge of the semi-membranosus tendon; divide the fascia lata; draw the tendon inward, the pulsation of the artery being detected by the finger. Pass the needle from without inward.

To expose the artery in the lower part of its course, make a vertical incision from the bend of the joint downward in the median line. Guard the external saphenous vein and nerve. Cut through the deep fascia and dense cellular tissue, when the artery, vein and nerve will be seen between the heads of the gastrocnemius. Draw the nerve inward, the vein outward and pass the needle from without inward.

**Posterior Tibial.**—(a) At the middle of leg. (b) Behind the inner malleolus.

This artery is the larger of the two tibials and extends from the lower border of the popliteus muscle along the tibial side of the leg, between the superficial and deep flexor muscles. It passes behind the inner malleolus midway between the heel and the tip of the malleolus, resting upon the internal lateral ligament. In the upper part of its course the nerve lies upon its inner side, in the lower part of its course upon the outer side.

**OPERATION.** (a) The leg rests upon its outer surface. Determine the inner border of the tibia. Make a four-inch incision parallel with and one-half inch behind the tibial border, through the deep fascia. Pull the gastrocnemius outward. Cut the lower tibial fibres of the soleus. Separate the superficial muscles from the deep; feel for the pulsating vessel which has a vein upon either side and is covered by the nerve; pass the needle from without inward. (b) A curved incision over the pulsating artery one-half inch behind the malleolus and through the annular ligament will uncover the vessel. Avoid the sheath of the posterior tibial muscle which lies close behind the malleolus, between which and the artery is the sheath of the flexor longus digitorum muscle. Pass the needle between the nerve and artery, from behind forward.

**Anterior Tibial.**—The artery lies upon the interosseous membrane and its course is marked by a line drawn from the inner side of the head of the fibula to a point over the middle of the ankle, from whence it passes forward under the name of the dorsalis pedis.

In the upper part of its course it lies very deep, beneath the tibialis anticus, and partly overlaid by the extensor longus digitorum, the extensor proprius pollicis, and the anterior tibial nerve. Below it is superficial, except where crossed by the extensor proprius and annular ligament, with the nerve on its outer side.

**OPERATION.** In the middle of the leg make a four-inch incision over the line of the artery, through the deep fascia; separate the anterior tibial from the extensor longus digitorum and find the artery upon the interosseous membrane. Avoid the venæ comites and draw the nerve



outward. For the lower portion of the artery make a two-inch incision along the outer border of the extensor pollicis to a point one inch above the tip of the malleolus; the artery lies between this muscle and the common extensor with the nerve on the outer side. Pass the needle from without inward. In these ligations flexion of the foot by relaxing the muscles will facilitate the work.

**Dorsalis Pedis.**—This artery lies over the tarsus along the outer border of the extensor longus pollicis, with the nerve upon its outer side. A two-inch incision over the course of the artery will readily uncover it with its veins. Ligate above the back part of the first interosseous space so as to be above the bifurcation of the artery.

SECTION XVI.  
**SURGICAL DISEASES AND INJURIES  
OF THE HEAD.**

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CHAPTER I.  
**THE SCALP.**

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**Contusions of the Scalp.**—These may be sub-cutaneous, sub-aponeurotic, or sub-periosteal, and produce blood extravasations of varying amount in the above named locations.

I. **SUB-CUTANEOUS.** These are the milder cases, the amount of the effusion being limited on account of the dense structure and the firm attachment between the skin and aponeurosis of the occipito-frontalis, to which aponeurosis the term galea has been applied. They may produce extensive discolorations.

*Treatment.* Cold applications and pressure will usually be sufficient. Occasionally, to prevent spreading discoloration, or to hasten absorption, incisions may be made. These are only permissible of course in the hairy portions, where the subsequent scar would not be seen.

II. **SUB-APONEUROTIC.** These injuries may be much more extensive, spreading widely over the head. They are particularly deceptive from their “crater-like” feel, giving the impression of a depressed fracture, because of their soft centre with a hard periphery. When in doubt an incision, under antiseptic precautions, is justifiable. The author recalls finding a badly comminuted skull, with extra-dural hemorrhage but without bone depression, under such a contusion. Such a hematoma, too, may further deceive by pulsating quite distinctly.

*Treatment.* Ordinarily cold applications and pressure, by means of a snug muslin, or even elastic bandage, and the ice-bag or cold arnica lotion will cause prompt absorption. In some cases the swelling persists a long time; if located so that the scar will not show an aseptic incision will enable the surgeon to turn out the clot, or he may pack the wound for a day or two. Such a clot is liable to infection and suppuration until absorbed.

III. **SUB-PERIOSTEAL.** These contusions are usually found in the new-born, and are known as cephalhematomata. The “caput succedaneum” consists of a serous effusion in the first two locations. Minute hemorrhages may coexist. The obstetric forceps, too, may produce contusions of the first two varieties. Sub-periosteal hematomata are apt to be confined to one bone, the periosteal attachment being firmer at the sutures. They are most frequently found over the parietal bones, occa-

sionally over the occipital. They have been met with in children and even in adults, the delicate attachment of the pericranium to the skull acting as a predisposing cause in the young. Pulsation and the same "crater-like" feel are present in this variety.

*Treatment.* The treatment is similar to that adopted in the former variety, with, perhaps, less frequent incision, unless the clot breaks down, when this incision is imperative.

**Wounds of the Scalp.**—There are several important points to remember in connection with scalp wounds:

I. Owing to the dense tissue and close attachment of the skin to the aponeurosis superficial wounds do not gape and rarely require suture.

II. The edges of wounds dividing the aponeurosis are apt to separate widely and must be closed.

III. Infection under the aponeurosis will be followed by extensive burrowing of pus, limited by the eyebrows, zygoma and superior curved line of the occiput.

IV. An aseptic condition, secured by the strictest antisepsis, is, therefore, imperative. The great dread of suturing scalp wounds in the past, through fear of erysipelas, was wholly due to dirty wounds. Sepsis may be prevented by shaving and cleansing a wide area and by thorough mechanical and chemical disinfection of the wound and its surroundings. The scalp, with its hair follicles and sebaceous and sweat glands, is a hot-bed of sepsis. For this reason silk-worm gut or silk, or, at least, not sheep-gut, are to be used for suturing, and temporary (forty-eight hour) drainage—preferably with a strip of gauze—should be employed to carry off the serum and blood, which would serve as an ideal culture-medium, spreading out as it does under the aponeurosis.

V. Hemorrhage from the dense scalp is hard to control, ligatures not holding; pressure, direct or by sutures, or a suture thrown around the bleeding point, the "umstechen" of the Germans, or temporary clamping with hemostats, giving the most satisfactory results.

VI. On account of the extreme vascularity of the scalp large portions may be torn off and hang down over the face and neck, and yet, if connected by a pedicle, they may be replaced, sutured, and if an aseptic condition is induced may unite by first intention.

VII. Stripping off of the pericranium is followed, at most, by a very superficial necrosis, hence it is safer to trim off ragged pieces of this fibrous membrane which is more liable to slough than the bone. The scalp flap, if aseptic, will quickly adhere to the skull and prevent necrosis, and even large areas of denuded bone will granulate and ultimately cicatrize. If infection is prevented there is no danger of deeper inflammatory complications. The author has seen three-fourths of the skull exposed by a machinery accident, the bone become covered with granulations and the wound close with the help of Thiersch skin grafts. The patient, naturally, has to wear a wig.

VIII. Next to the induction of a certain asepsis, or even of greater importance, is positive information of the condition of the skull. Hence all scalp wounds, except, perhaps, those that are very superficial, should be opened to the bone, at least to their fullest skin extent, and the skull should be inspected as widely as possible. In the absence of cosmetic contra-indications they had better be enlarged if there is the slightest



shadow of a doubt. This is imperative in penetrating wounds, and those produced by sharp bodies. With strict antiseptic technique such a step is absolutely without danger and saves many a life.

**VARIETIES.** Wounds of the scalp may be divided into incised, contused and lacerated wounds. It is worth remembering that a clean-cut wound may be produced by a blow from a blunt body.

**TREATMENT.** The treatment of all three varieties is practically the same, whether the cut be made by the point of a small penknife or the whole hairy scalp be wrenched off by the hair getting entangled in machinery.

I. The scalp must be shaved for a considerable distance in every direction.

II. The whole area must be thoroughly scrubbed with soap and water, ether or carbolic solution, and kept wet with bichloride solution.

III. Ragged edges of the wound and of the pericranium should be trimmed off.

IV. Hemorrhage is arrested by ligature if possible, or by clamping, pressure, or suture.

V. The wound is opened to the skull, throughout its full extent, even enlarged, and the bone carefully inspected and percussed.

VI. Sutures, preferably of silk-worm gut, are passed through the whole thickness of the scalp, an opening being left at a dependent point or a counter-opening being made for gauze or horse-hair drainage.

VII. The dressing consists of sterile protective wet with bichloride, sublimated sterile gauze and a bandage. The whole is best kept in place by adhesive strips surrounding and crossing the head.

VIII. The wound is dressed in forty-eight hours, the drain removed and sublimate gauze, with or without aristol, iodoform, or acetanilid powder applied. The wound is re-dressed every second day and the temperature watched.

IX. The operator's hands, instruments, dressings, etc., are prepared according to the strictest antiseptics.

Personal experience enables the author to assert that sepsis is unknown when these rules are followed.

Scalp wounds that heal by the first intention, and those in which, before closure, skull lesions have been excluded, are rarely followed by subsequent trouble. Those, however, that do not so heal are apt to be followed by nervous manifestations of a more or less serious nature. Neuralgias, for instance, are met with, these appearing to be due to pressure on nerve fibres by the cicatrix. When pain can be located in the scar this may be dissected out, and when it occurs along a nerve trunk this may be divided or a portion removed.

Again, epileptic seizures following a head injury may be induced by pressure upon such a cicatrix. In such cases complete excision of the scar would constitute the first step for the relief of the condition, the presence of bone lesions, and, when these are removed, evidences of intracranial mischief, calling for further interference. In some cases it would look as if such operations benefitted by suggestion, subsequent relapses showing that they were not curative.

**Suppurative Inflammation of the Scalp.**—Chronic, "cold" or localized abscesses may occur from a variety of causes, as in connection

with a general furunculosis or with skin inflammation, such as eczema, as a sequel of typhoid fever, of contusions, or from the extension of neck carbuncles, in syphilitic, or tubercular and marasmic patients. These are of comparatively slight importance, requiring the same local, dietetic, hygienic and remedial treatment as in similar lesions elsewhere.

The most important variety is the infective one, produced usually by the corner drug-store surgery and adhesive-plaster treatment of scalp wounds, or their immediate close suture by careless, even dirty, doctors. These inflammations are apt to assume the type of phlegmonous erysipelas or diffuse cellulitis, and are dangerous, both in their local and constitutional effects—as gangrene of the skull, septic processes within the cranium by infection through the emissary veins and cranial nerves, high fever, delirium, pyemia, exhaustion, death. The symptoms of such a process would be general headache, local pain, throbbing, with some swelling and an erysipelatous blush, a rise of temperature, and, occasionally, a rigor. If the pus is under the aponeurosis, edema of the eyelids will often sound the first alarm. The author recalls a case of extensive lacerated wound of the scalp into which mud, grease and hair had been sewed with dirty silk. The first observed symptom was a complete closure of both eyes. The edema was enormous, while the scalp floated like a bog on a lake of pus over the whole extent of the occipito-frontalis.

**TREATMENT.** This cannot be instituted too soon or too thoroughly. The stitches are at once removed from the wound. The accumulation of pus is followed by free and dependent incisions in every direction. Peroxide of hydrogen and then sublimate solution are used for cleansing, and the cavity is lightly packed with iodoform gauze, the whole being covered with a generous, absorbent, sublimate dressing. The temperature is watched, and bags or pockets of pus laid open and energetically disinfected as soon as found. Subsequent mutilation by scars must be thought of, but often has to be disregarded. Nourishing and easily assimilated diet, with free stimulation at times, will be needed, and such remedies as would be called for by fever, delirium, prostration and the typhoid state, foremost among which will be arsenicum, rhus tox., bryonia, baptisia and belladonna, are demanded.

**Erysipelas of the Scalp.**—Cutaneous erysipelas is usually an extension from a similar process in the face or neck, and is to be distinguished from that originating in wounds and associated with suppuration, as referred to above. It is especially to be feared in alcoholics, and may be associated with symptoms of meningeal inflammation.

The treatment is that of erysipelas in general, both medicinal and local.

Arnica in the first stage, arsenicum if severe constitutional prostration ensues, china, silicia and secale for septic states, with general unhealthfulness of tissues, pretty well cover the list of remedies likely to be required.

**Syphilis of the Scalp.**—Secondary syphilitic lesions are of frequent occurrence in the scalp, the primary forms of eruption showing themselves in the face, and especially in the hairy scalp, in most cases. The favorite location of the later papular eruption is along the hair border of the forehead, known as the “corona veneris.” Here, as well as at



the posterior hair line, are also found tertiary manifestations, as gummata, which often go on to ulceration, and in so doing assume a kidney shape, with scalloping on the hollow side. There is the general falling of the hair of the second stage—the hair presenting the characteristic dry, crackling feel, but growing again to its former extent—and the localized alopecias of the tertiary stage, which are apt to be permanent.

**TREATMENT.** The treatment is that of syphilis in general.

**Emphysema of the Scalp.**—**ETIOLOGY.** Emphysema of the scalp is produced, as in other portions of the body, by the entrance of air into the loose connective tissue. It is accordingly met with about the nose and its tributary sinuses, and the mastoid.

**TREATMENT.** Such accumulations of air are principally of diagnostic importance, indicating fracture, and require no special attention beyond pressure. If they attain a considerable size they may be emptied.

**PNEUMATOCELES.** In rare cases gaseous tumors are met with, usually behind the ear, and occasionally over the frontal sinus, without a history of previous traumatism. They are called pneumatoceles, and are due to absorption or defects of the bone covering these air cavities. They are elastic, resonant on percussion, can be reduced by pressure, which sometimes causes dizziness and is accompanied by air sounds, and may be increased in size by sneezing, coughing, or “blowing out” the ear. Puncture will settle the diagnosis.

**Treatment.** Pressure after evacuation by puncture will usually suffice. Incision and packing, and irritating injections have been used.

**Tumors of the Scalp.**—**SEBACEOUS TUMORS.** Wens or atheromatous cysts are by far the commonest growths met with in the scalp. They are retention, sebaceous cysts and are apt to be multiple. They vary in size from that of a pea to a small orange. (Fig. 445). At times they inflame from irritation, when their contents are found extremely offensive. The odor is both disgusting and adhesive. Rupture may follow, with protracted discharge. The long continued irritation may result in the heterologous development of epithelial elements, i. e., carcinoma.

**Treatment.** Complete excision is advisable, both for cosmetic reasons and on account of their tendency to inflame. The sac should be dissected out entire, and if the cyst ruptures, as it often does, it should be pulled out piecemeal or thoroughly curetted. Cocaine anesthesia (two per cent. solution under the skin with two per cent. carbolic acid in boiled water) is usually sufficient. In the hairy scalp the wound can be lightly packed for a day or two and then covered with an antiseptic compress. Where the scar will be visible, accurate suture should be practiced.

**Dermoid Cysts.**—These are congenital and contain, as elsewhere, hairs and sebaceous matter; they are found at the lines of union, the outer



Fig. 445. Wens of the Scalp.



angle of the orbit and the root of the nose. They are usually very small, but may grow rapidly and as quickly shrink or become inflamed. Unlike hernia they are not influenced by pressure, external or intracranial, and do not distinctly fluctuate.



Fig. 446.  
Carcinoma Originating  
in Right Orbit.—  
Van Lennep.

TREATMENT. If irritated or growing or a source of annoyance they should be carefully dissected out.

**Cornu Cutaneum.**—Horny excrescences are occasionally met with in old subjects. They are epidermal growths and had best be excised. If picked off or allowed to drop off they recur.

Warts need attention only when they are irritated or prove a source of annoyance. Like horny excrescences, their epithelial character makes a carcinomatous change possible if they are subjected to irritation.

TREATMENT. Thuja, internally and locally, is often curative. Caustics should never be used, clean incision being the next step.

**Moles.**—Both the hairy and the pigmented mole are found about the head and need attention only for cosmetic reasons. The possibility of carcinoma and of sarcoma developing from them should forbid any irritative treatment. If a cause of disfigurement, they are to be excised and the defect closed by suture, skin grafts, or a plastic operation.

**Carcinoma.**—Cancer not infrequently appears about the head, the forehead being most often affected. It may develop, as already stated, from irritated wens, warts or moles. Its characteristics are the same as elsewhere.

TREATMENT. Excision must be early and radical to be successful, the entire scalp, the pericranium, and even portions of the skull being removed. The age of the growth and the thoroughness of the operation have an important bearing on the prognosis. Lymphatic nodes must be looked for and removed, the parotid, mastoid and occipital glands becoming infected from the scalp, while infection would follow the facial vessels into the submaxillary glands from the forehead.

**Sarcoma.**—Sarcoma more frequently springs from the periosteum or bone, involving the scalp secondarily. So do the chondromata and osteomata. Lipomata are met with occasionally but need no special notice. Fibromata may occur as the minute "fibroma molluscum" on the eyelids or ears, or as elephantiasis. The only treatment is excision.

**Vascular Growths of the Scalp.**—**ANEURISM.** Simple aneurisms are usually met with in the temporal arteries and are of traumatic origin. They are easily diagnosed, but as they attach themselves to the skin at times and spontaneously rupture they may be mistaken for abscess. The author knows of at least one instance in which such a mistake occurred in very competent hands.

TREATMENT. The method of Antyllus, ligation above and below, with excision or evacuation, is easily carried out. Occasionally compression may effect a cure.

**Cirroid Aneurism.**—Cirroid aneurism, or, from its derivation, varicose aneurism, is known by a number of names, e. g., arterial varix,

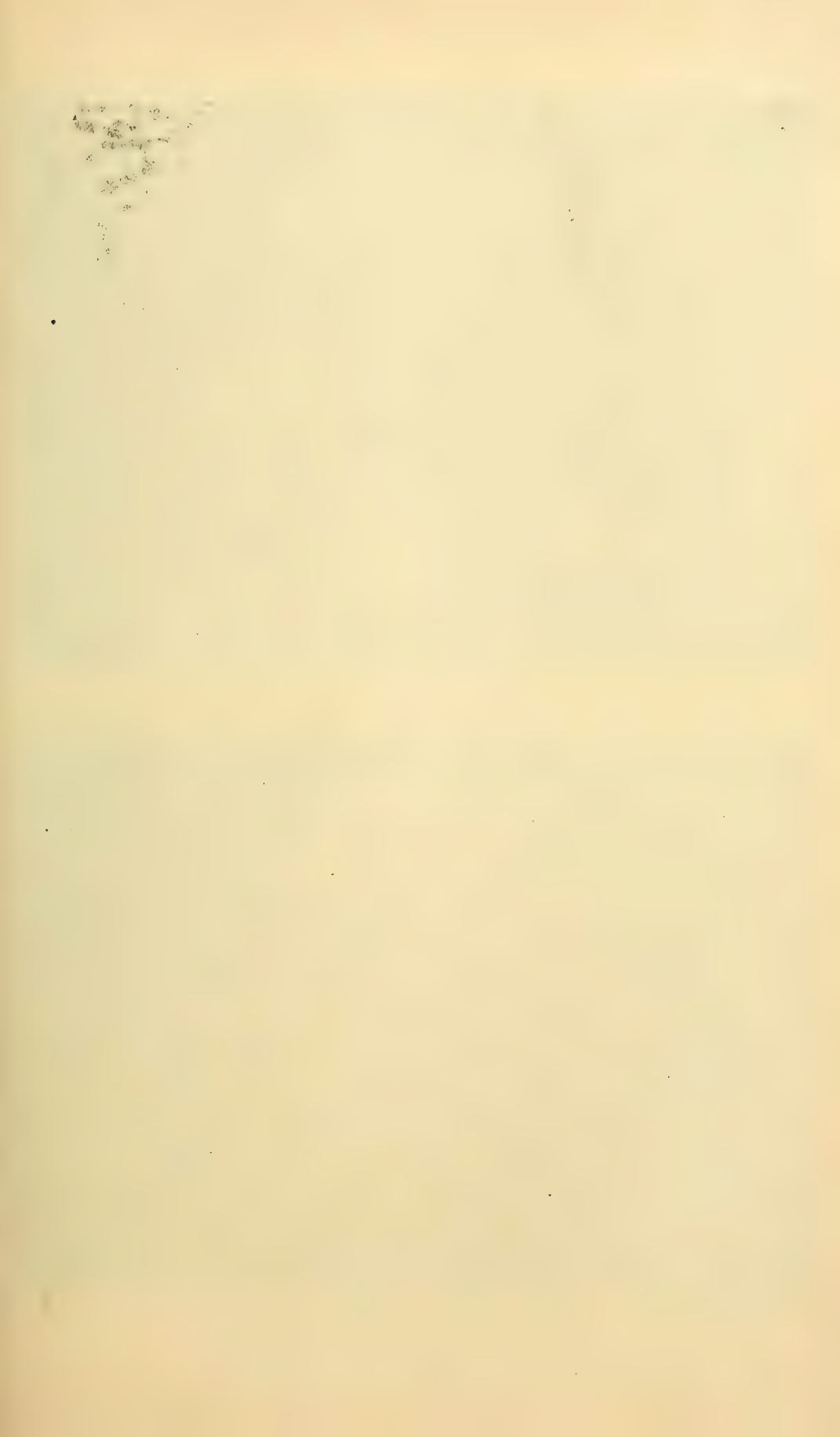




Figure 1. Front View.



Figure 2. Lateral View.

PLATE XIV.—CIRROID ANEURISM.



racemose aneurism, etc. Essentially an artery and its branches, even its capillaries and veins, and often its anastomoses, are dilated and elongated, the dilatation taking the form of pouches, as in varicose veins, through a thinning of the middle coat. This thinning may result in rupture. These growths are met with mostly in the scalp, or in the wrist and hand. More accurately, as regards the head, the distribution of the temporal, posterior auricular, and occipital arteries are usually involved. Occasionally a communication takes place between an artery and a vein, giving rise to what is known as arterio-venous aneurism, or aneurism by anastomosis; more frequently, however, the veins become involved through the dilated capillaries.

**DIAGNOSIS.** The diagnosis is usually easy, by noting the pulsations, controlled by pressure on the carotid, and the tortuous and sacculated vessels. There may be a history of traumatism or a pre-existing nevus. Puberty and pregnancy seem to accelerate the growth. The commonest age is between twenty and thirty.

Plates XIV and XV illustrate a rare form of cirroid aneurism; originating, presumably, in the traumatism that produced a fissured fracture of the right frontal eminence, it involved the supra-orbital artery and its branches and anastomoses to the vertex, caused absorption of the supra-orbital canal, and extended to the orbital branches of the ophthalmic artery, including the parent trunk, which easily admitted a finger. Rupture seemed imminent. Exophthalmos co-existed, with complete amaurosis. The right common carotid was ligated, a scalp flap raised, and the dilated vessels were excised, together with the eye. Recovery was retarded by purpura.

**TREATMENT.** This is dangerous and often unsatisfactory, especially so with direct excision, which requires a cool head and a dexterous technique. Preliminary ligation of a carotid facilitates the operation and lessens the danger if done with antiseptic precautions; it is to be preferred in large growths. Multiple ligation, either interrupted or Barwell's continuous, scarless ligation, has been practiced with success. Barwell's method consists of the introduction of a needle armed with heavy silver wire through the skin at a point just outside the margin of the tumor. The needle is passed onward beneath the skin for quite a distance and then allowed to emerge to be re-entered again through this same opening, this procedure being repeated until the subcutaneous stitch encircles the tumor and emerges through the starting point. The wire is drawn tighter from day to day till its loop finally comes away. This is not recommended for large tumors. Galvano-puncture and coagulating injections of alcohol or iron chloride have been used. The latter is to be deprecated as dangerous.

**Nevus or Mother's Mark.**—I. Nevus is met with as a "port wine stain," made up of fine capillaries, and not elevated above the skin. It is congenital and does not subsequently grow. The diagnosis is self-evident. The treatment is not very satisfactory, especially if the stain be large. Excision, and suture or grafting, multiple scarification of a section at a time, and electrolysis have been used.

II. "Strawberry tumor," made of large capillaries, and projecting above the skin, is explained by its name. It is usually present at birth, or is noticed soon afterward, and grows steadily, at times attaining a large size. It may be associated with the preceding variety. It may rupture

and produce serious hemorrhage. The diagnosis is indicated by the name.

**TREATMENT.** If growing, the sooner these nevi are removed the better. Subcutaneous ligature is extensively employed for this purpose. Excision is usually preferable, and is not associated with dangerous hemorrhage, provided the knife is kept just outside the growth. The defect can be closed by suture or Thiersch skin grafts, the resulting cicatrix being less unsightly than that following ligation.

**Venous Tumors.**—Venous tumors may occur as varices in the frontal or temporal regions and require attention only when rupture is threatening; they should then be excised.

Again, a sacculaton of venous blood may be found between the periosteum and the skull from injury to emissary veins, and this may communicate even with a sinus. Bone depression or absorption is also present.

These tumors do not pulsate, have no bruit, and may be reduced by pressure. Incision has been followed by such severe hemorrhage that they had best be left alone in the absence of positive indications for interference.



Figure 1.  
After Operation; Superior View.

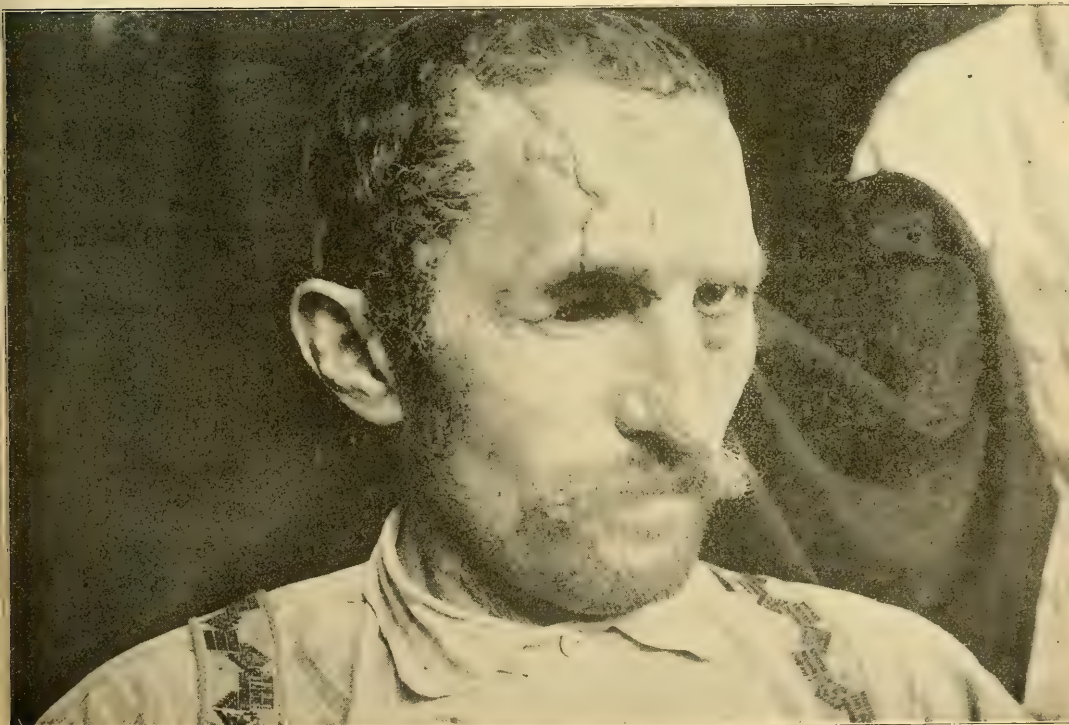


Figure 2.  
After Operation; Lateral View.

PLATE XV.—CIRSOID ANEURISM.





## CHAPTER II. THE SKULL—FRACTURES.

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**General Considerations.**—Cranial fractures are considered under diseases and injuries of the head, instead of with fractures of the other bones, because they owe their importance to the coincident or resulting lesions in the brain and its membranes. In themselves these fractures present but few difficulties as regards repair. Splints, for instance, are not necessary because muscular action plays no part in producing a recurrence of the deformity. When once “set”, then, the fragments stay in place. Provisional and exuberant callus is practically unknown, although occasionally met with, both externally and, more especially, internally. In the latter location such callus may produce pressure on the cranial contents. Union takes place by definitive callus between the fragments, and is thrown out by the diploë. Ossification, however, is slow and may never take place, fibrous union being common. The latter is sure to occur if there is any loss of bony substance. Loose fragments, unless very small or sufficiently attached to insure a vascular supply, are apt to necrose and be cast off; when they live they take their nourishment from the dura rather than from the pericranium and become adherent to the former. This fact, together with that of the callus formation, proves the dura to be more nutritive than the periosteum of the skull. Hence it is safer to remove such fragments and not to replace them.

The brain is peculiarly well protected against injury by, first, the thick, tough scalp, then the skull, made up of arches which are particularly strong front and back, in the middle line and on either side of each temporal fossa, and consisting of two plates with an intervening pad or diploe. The bones of the cranium, too, have a certain amount of elasticity which is enhanced by the sutures; this is especially the case in children, whose ununited sutures and elastic bones serve them in good stead in their numerous bumps and falls. This elasticity is well illustrated by filling a skull with paraffine and allowing it to drop from a moderate height. The bone dents the paraffine under the point of impact and springs back again to its original position. The brain is further protected by the stout dura, while it is padded by the other membranes and the cerebro-spinal fluid. The lateral regions have, besides, a muscular cushion. This elaborate protection is at times one of the greatest sources of danger; inflammatory and hemorrhagic effusions, bone depressions, new growths, etc., exert disastrous pressure on the brain, as the skull will not stretch like the abdominal and, to a less degree, the thoracic walls. Hence one of the most frequent therapeutic indications is the relief of tension.

The skull is particularly thin in the roof of the orbit and nose, and in the occipital bone, on either side of the middle line; on the other hand, at the mastoid, occipital protuberance and the frontal sinuses it is unusually thick. The base is a weak portion, on account of its complex make-up, its scanty diploë, and its many openings of exit or entrance for

nerves and vessels. It is well protected, however, throughout most of its extent by the heavy muscles of the neck and by the face.

In frequency cranial fractures constitute not more than two per cent. of all fractures, and occur mostly in adult males, those who are exposed to accident. Children sustain such injuries more often than is generally supposed, and they are not uncommonly produced during parturition.

**Varieties.**—Fractures of the cranium may be of the vault and base, compound and simple, complete and incomplete, fissured, comminuted, depressed, and punctured—which may be further divided into penetrating, non-penetrating and perforating.

**Fissured Fractures.**—Fissured fractures are cracks running from the point of injury in any direction; they may be single or multiple, bifurcating or radiating, limited or extending even completely around the skull. The author recalls a case in which mobility could be felt between the anterior two-thirds and the posterior third of the head by grasping the occiput and forehead and pushing them in opposite directions. Such fissures may, exceptionally, be limited to the outer plate, constituting an incomplete break. In rare instances a suture may give way, either alone or with a fissure, constituting a diastasis.

**Comminuted Fractures.**—Comminuted fractures are those in which the bone is broken into a number of pieces. The splintering is apt to be more extensive in the inner plate, spicules of which may stick into the dura, or even perforate it and puncture the brain. Fissures may radiate from such a comminution, and one or more of the fragments may be depressed.

**Depressed Fractures.**—Depressed fractures may be comminuted, or even, in elastic skulls, fissured, but besides being broken the bone is pressed down below the level of the surrounding skull. This may occur at the centre of a comminution, may be produced by the depression of a fragment, or by the tilting of the same, one edge being pressed under the intact bone. In rare instances a fragment may be impacted by being driven into the adjoining skull. Bone depression, per se, may be tolerated by the brain to a remarkable degree, much more so, it is claimed, than pressure from a clot, this being especially the case in the young. While early mischief may not show itself, provided septic processes are escaped, the remote effects on the brain are to be dreaded.



Fig. 447.  
Depressed Fracture of Skull.  
Site of Depression and Line of  
Suturing—Shears.

**Punctured Fractures.**—These are made by a more or less pointed instrument which penetrates the scalp, fractures the skull, and may go through the latter and enter the brain. A piece of the weapon is often broken off and remains in or inside the skull. Septic meningitis, or, later, brain abscess may result, although the occasional toleration of the brain to such bodies is remarkable. Consequent inflammatory mischief may not develop for a long time, sometimes for months or even years. Depression and comminution, especially of the vitreous plate are often associated. These fractures



have been termed penetrating and non-penetrating, according to whether they perforate the skull or not. If the vulnerating force or object enters the cranium, goes through and out at the opposite side, it produces what are known as perforating fractures. In such a lesion the inner table will be more extensively comminuted at the point of entrance, while the reverse will be the case at the point of exit. Penetrating wounds are apt to be deceptive on account of the elasticity of the skull; thus, a foreign body may enter the cranium and leave no lesion in the bone further than a fissure. Occasionally a single hair, a piece of dirt or clothing has led to the necessary exploration. Fissures of the base, even associated with rapidly fatal intracranial lesions, are often so fine as to be imperceptible without maceration of the skull.

Gunshot wounds belong to this class and are not uncommon. The modern missile, with its high velocity, usually produces a perforating wound, although penetration alone is met with, especially with pistols. The bullet may strike the skull opposite, be deflected, and plough its way through the brain again, in an entirely different direction.



Fig. 448.

**Gunshot Fracture.—Opening of Exit. Fissured Fracture.**—Museum Hahnemann Medical College, Philadelphia.



Fig. 449.

**Fracture of Skull with Loss of Substance; View of Base Showing Joint into Foramen Magnum.**—Museum Hahnemann Medical College, Philadelphia.

Such a track has been recognized, and successfully drained through a trephine opening at the points of entrance and impact. Contusion or incomplete fracture by spent balls is practically unknown to-day; fully one-half of the rifle shot fractures are immediately fatal. Suicides are apt to reach the base of the skull by discharging the bullet through the mouth.

**Complete and Incomplete Fractures.**—These terms explain themselves. In the former the inner table is apt to be more extensively broken, or, rarely, the lines of fracture may not correspond, as a fissure of one crossing one of the other, or, quite commonly, a fissure of the outer with splintering of the inner table. The latter is of especial importance. In incomplete fractures either table may suffer, the outer being by far the more frequently affected. This

may be indented or fissured, and over the thick portions, as, for example, the frontal sinuses, it may be considerably depressed or comminuted. As a rule, unless such dents and cracks are very slight, it may be inferred that both plates are involved.

Contusions of the skull belong to this class. If the scalp remains intact or infection is prevented circumscribed periosteal thickenings or nodes may result; these may subsequently ossify, forming exostoses, or, more frequently, be absorbed. If infection take place, or, rarely, if traumatism destroy the vitality of the bone, necrosis of varying, and at times of considerable, extent may follow. If the vascular diploë be exposed and infected osteomyelitis and thrombosis are to be expected, with their systemic and intracranial results.



Fig. 450.

Fracture of Skull with Loss of Substance; Side View Showing Radiating Fissures.—Museum Hahnemann Medical College, Philadelphia.

Fractures of the inner table are considered quite a rarity, but their exclusion must needs be largely inferential. The author recalls the case of a sailor who fell down a hatchway, head first, and was in profound coma when seen. There being absolutely no localizing symptom, the entire, contused scalp of the vault was laid open, with negative result. A small spicule of the inner table had been broken off, perforating the dura, and dividing a good-sized vessel on the surface of the brain, an enormous hemorrhage resulting. In

the young, we may meet with a species of green-stick fractures, the bone being depressed, the inner plate, which is the outer side of the curve, giving way.

**Simple Fractures.**—Simple fractures, or, more correctly, closed ones, are, as elsewhere, those that do not communicate with the outside air. They may be fissured, comminuted, or depressed.

**Compound Fractures.**—Compound fractures, on the other hand, known also as open ones, are associated with wounds of the soft parts. It is of importance to remember that fractures of the roof of the nose or orbit are often compound through wounds of the frontal sinuses and nasal mucosa, while those entering the mastoid cells or middle ear allow access of air through the auditory canal or the Eustachian tube.

**Fractures of the Vault and Base.**—Such a classification is necessary, largely on account of the inaccessibility of the latter to operation; they also present some diagnostic differences. Probably three-fourths of all cranial fractures are of the vault; they often extend, however, from the vertex or sides and back to the base, most frequently crossing the middle fossa. While more rare, those of the posterior fossa are very fatal, and, as just stated, those of the anterior fossa have an element of danger in often being compound.

**Fractures of the New Born.**—A classification of fractures of the skull would not be complete without reference to those produced



during parturition, usually by forceps delivery. While it is true that many deformities which are produced by the presentation or the shape of the pelvis will right themselves in time, the same is not true of actual fracture. Death usually results, or if the child survive, paralysis and other cerebral lesions will appear. Operation for the correction of such depression offers a life-saving and preventive chance which should not be neglected.

**Causes.**—Fractures of the skull may be produced by direct or indirect violence, as a fall on the head or a blow on the chin driving the condyles into the auditory canal or even into the cranial cavity. Again, the vulnerating force may be circumscribed, diffuse or multiple; for instance, a missile, a fall on a flat surface, or one on the vertex, the object struck producing one force while the weight of the body acting through the spinal column produces the other. A circumscribed violence will spend itself at the point of impact, inflicting a localized lesion, usually with depression; a diffuse force will act at the point of impact and will also cause spreading lesions, such fissures running around to the base. Multiple forces will cause multiple lesions, or seemingly even burst the skull.

Fracture by counterstroke or *contre coup* is often mentioned but is in reality a rarity. By it is meant that violence applied on one side of the skull causes a fracture at a point directly opposite. Rupture of a meningeal artery or brain laceration is the lesion usually produced in this manner. Much more frequent are fractures by radiation. Thus, falls on the side of the head, which are common, will cause fractures radiating to the petrous and middle fossa. Injuries to the back of the head may in like manner spread to the posterior fossa, while violence transmitted along the line will spend itself about the foramen magnum. Fractures of the frontal bone are apt to run into the orbit or cribriform plate and on through the anterior fossa. This fossa is also often reached by sharp bodies, such as umbrellas, canes, fencing foils, or bullets, etc., which enter the orbit, nose, or roof of the pharynx. Such injuries are especially dangerous because they are overlooked and because dirt or portions of the vulnerating body remain within the skull.

**Symptoms.**—Closed fractures of the vault are often hard to diagnose. The deceptive impression given by a bruised scalp has already been referred to. Bony defects from syphilitic or old traumatic lesions, atrophy and congenital peculiarities may also mislead the palpating finger. With a proper antiseptic technique any doubt can safely be removed, as already stated, by incising the scalp.

In open fractures inspection makes the diagnosis more easy, but the advice already given should be followed—to enlarge such wounds to the bottom, to their fullest extent, or more, and examine the skull as far as possible in every direction. The fracture will otherwise often escape detection. The author recently saw a case in which a wound of the forehead had been sutured because only the insignificant end of a fissure was seen through it. Further examination showed a comminuted, depressed fracture of half the forehead and of the roof of the orbit and nose, which, of course, was doubly compound. By bearing in mind the location of the bony sutures, and remembering their occasional occurrence around a Wormian bone, another source of error may be avoided. A slit in the



periosteum has been mistaken for a fracture. Blood, too, is apt to ooze from a fissure, while this lacks the dentation or the overlapping of a suture.

Percussion of the head has been said to give a cracked-pot sound when fracture is present. Rather extensive comminution is necessary to elicit this through the scalp, and, while it may be recognized by percussing the bare skull when only a fissure is present yet its absence does not exclude fracture.

Crepitus is occasionally recognized through the swollen scalp and will settle the diagnosis of fracture and of comminution usually. In the case of completely encircling fissure referred to above crepitus was present. In one case of the author's the entire vertex was splintered, and the fragments felt like a lot of pebbles floating on a water-bed.

Localized pain and tenderness have been mentioned as diagnostic. It is probable that the scalp injury has more to do with this than that of the bone. It has been observed that a clean-cut wound and underlying fracture were neither painful nor tender as compared with a neighboring contusion of the scalp.

The escape of cerebro-spinal fluid is pathognomonic; if it can be gathered it will be found to contain chlorides and a trace of sugar and albumin at times. In a closed fracture it will produce a swelling, often translucent and pulsatile. It is termed cephalhydrocele. This will be enlarged by hanging the head, or during expulsive efforts, such as sneezing, coughing, or blowing the nose. The same is true of open fractures. It is said that the escape of this fluid in fractures of the vertex justifies the suspicion that a ventricle has been opened. Attempts to reduce such a swelling may produce symptoms of brain pressure. Children are particularly apt to show this swelling. It led the author, in one instance, to discover a depressed fracture, with extra-dural hemorrhage. Some writers have termed this the "puffy tumor of Pott," which is rather the edematous, septic scalp, associated with a wound, a fracture and intracranial infection. In fractures of the base this flow is of especial diagnostic value, particularly when coming from the ear, less so from the nose or pouring into the naso-pharynx. It shows that the subarachnoid space has been opened. It will present the characteristics of cerebro-spinal fluid, besides which it should appear in considerable quantity, several ounces to even a pint in twenty-four hours. Position and expulsive efforts will increase the flow. Again, the fluid may be the serum at the end of a hemorrhage from these orifices, or that exuding from an irritated mucous membrane, or, rarely, the liquor Cotunnii from the internal ear. Such serum will solidify on boiling.

Hemorrhage of intracranial origin will also be abundant, persistent, usually immediate, sometimes pulsatile, and increased by whatever favors cerebral congestion. It is of diagnostic value when coming from the ear or nose. Other possible causes of the bleeding must be eliminated. In either case the blood may appear in the naso-pharynx, or be swallowed, and subsequently vomited. If the drum-head is intact, blood or cerebro-spinal fluid must, of necessity, appear at the nose or in the throat. The practical point to bear in mind is that all fractures associated with these two symptoms must be compound. Aside from the primary or actual hemorrhages, ecchymoses are of diagnostic value. They may appear early, or late, when they will present the greenish-yellow charac-

ter seen in fractures elsewhere, partial absorption of the coloring matter having taken place during their journey from deep parts to the surface. As an early manifestation ecchymosis of the lids, limited to them alone, aids in the diagnosis; it usually comes later than the ordinary "black eye." In connection with this a progressive, conjunctival ecchymosis is corroborative, if not more suggestive. To this is occasionally added exophthalmos. The author operated a case in which ecchymosis of all four lids led to a diagnosis and exploration for fracture of both orbital roofs. Coincident indications of pressure on the optic nerves by blood or bone are sometimes present—of the later manifestations ecchymoses appearing about the mastoid point to fracture of the middle fossa, and those below its tip, spreading downward into the neck and upward and backward over the scalp, to a similar lesion in the posterior fossa. Effusions of blood may also take place in the roof of the pharynx and even extend down in front of the vertebral bodies.

Escape of brain substance, if recognized, must settle the diagnosis. Still, mistakes have been made. Aside from the appearances of brain tissue pulsation should be present. It is evident that this symptom must be of the greatest prognostic import, the scalp, skull, dura and brain being injured.

Emphysema may occur, as a consequence of cranial fracture, when a cavity containing air, such as the mastoid or frontal sinus, has been opened. It does not follow, of course, that both tables are broken.

**INJURY TO CRANIAL NERVES.**—Those most frequently torn or compressed are the facial, auditory and optic. The effect of such injury is immediate and usually permanent. Compression by blood will come later, more slowly, be less complete, and may disappear. A nerve lesion of the facial usually produces a more complete paralysis than a central one. Atrophy of the optic nerve follows, even though the pressure be relieved. Neuritis, with or without choked disc, will be noticed. Deafness is often not appreciated; vertigo from injury to the labyrinth is occasionally associated. A case operated recently was that of a man who had fallen, when drunk, and had been under treatment three days for delirium tremens, an attack similar to previous ones. He presented a boggy swelling over the ear, and a facial palsy of the same side. Exploration showed a fissure, starting at the upper posterior portion of the squamo-parietal suture; bifurcating, one branch ran forward to the orbit and the other downward and forward to a depressed comminution, under which were found extra- and sub-dural hemorrhage, a divided dura, and laceration and disintegration of the temporal lobe, the brain substance oozing out. Deafness was subsequently observed and the palsy was unchanged a month later. Another patient had complete amaurosis from a fracture involving the optic foramen. Elevation of the fragment was followed by restoration of vision; the ensuing nerve atrophy has improved considerably.

Of course, presumptive evidence of fracture is given by brain symptoms. By these are meant exaltation or depression, even abolition of intellectual, motor, or sensory functions, showing themselves as delirium or stupor, hyperesthesia or anesthesia, spasm or paralysis. Their greatest value is in deciding the question of operative interference.

**Treatment.**—To treat these fractures properly we must have an intelligent understanding of their results. Their greatest danger lies in

the coincident injury to the brain and its membranes. Of the results, the one most to be dreaded is septic inflammation. This may show itself early, as a meningitis, occasionally localized, but, more frequently, rapidly becoming universal, spreading to the membranes of the cord, or involving the brain substance until an encephalitis is present. At times its course is fulminating, killing in a few hours. Again, such an infection may show itself after a considerable period as a brain abscess, or in the lighting up of an apparently smouldering meningitis. Lastly, the septic process may destroy the bone or set up an osteomyelitis which, in turn, infects the brain and the system.

Pressure is the menace next in importance, and is usually caused by depressed bone and, especially, by blood and inflammatory effusions which encroach upon the brain, as the skull will not stretch. Irritative inflammation may be produced by brain laceration or by foreign bodies, such as splinters, bullets, or clots, the resulting effusion often causing disastrous pressure. It is the remote effects of such irritation, however, that have been particularly emphasized of late years; for example, a ragged wound of the brain, a depressed spicule of bone, the cyst left by the absorption of a clot, have all proved sources of persistent or late irritation. As a result, headaches, epilepsy, imbecility and insanity are frequently met with, and, what is of greater practical importance, are more incurable the older the lesion and more surely prevented the earlier the irritant is removed. To sum up, sepsis must be prevented, pressure relieved or vent given for the relief of tension, and all irritants removed.

If accessible, brain lesions must be treated, clots and foreign bodies being removed and lacerations drained. Early operation and antisepsis are the keynotes of treatment to-day. These have reduced the mortality of operated fractures of the vertex full thirty-fold, while the latter, particularly, has exercised a marked influence upon the results of fracture at the base. In considering the question of mortality even the low death-rate of to-day should not be laid at the door of operative interference. Operations on the skull, if properly performed, have no mortality; it is the mischief done by the injury or sepsis that kills. The only caution needed is to withhold the hand in hopeless cases or where operation is unnecessary. To this should be added another caution: no one is justified in operating skull and brain injuries unless he be master of an antiseptic technique, or an aseptic technique bred of an antiseptic conscience, that will exclude wound infection and control it if present. Without technique and judgment the head had better be left severely alone, as it was on the Kismet principle of the Mohammedan for over half of this century.

In fractures of the vertex we can start out with the broad proposition that every recognizable break requires interference and that the persistence of brain symptoms calls for exploration.

Punctured fractures invariably demand trephining, whether penetrating or non-penetrating. They are compound, the inner plate is more extensively broken and the membranes and brain are often injured. Gun-shot fractures belong to this class and therefore must be similarly treated. It is still an open question to what extent the brain itself should be interfered with. Certain it is that undue efforts to find deep-seated foreign bodies are to be deplored. Bullets in the brain have become encysted and either did no harm or did not indicate their presence for a long time.



Those easily reached should be removed and thorough disinfection and drainage obtained. In perforating wounds the indications are through-and-through disinfection and drainage, or double drainage if readily accomplished, or a counter-opening for the same purpose, and to remove the bullet, the probe or localizing symptoms being the guide. The probe is very apt to wander from the bullet track in the soft brain tissue.

Compound depressed fractures should always be elevated, the inner table and dura examined and most scrupulously disinfected.



Fig. 451.  
Fluhrer's Aluminum Gravity Probes.

Simple depressed fractures require similar treatment, if only as a preventive measure. With the wound-healing of to-day the additional gravity of converting a closed into an open fracture does not deserve consideration.

Compound comminuted fractures call for the removal of loose fragments, search for splinters of the internal table, examination of the cranial contents, and accurate disinfection.

Simple comminuted fractures require the same examination for sources of irritation and pressure, as well as the removal of all loose fragments.

Compound fissured fractures should receive some sort of operative attention. When we recall the elasticity of the skull, the fact that a foreign body may enter the cranium and leave but a fissure behind, that a hidden hair or bit of dirt may be sufficient to start an infection, and that the internal table suffers more than the external, the importance of such investigation becomes evident. The outer table at least should be removed, in



Fig. 452.  
Morgan's Trajector.—Dennis.

order to examine the inner and thoroughly disinfect it.

Simple fissured fractures cannot be recognized and therefore do not justify operation.

Multiple, widely radiating, and bursting fractures are too generally looked upon as hopeless on account of accompanying brain lesions, or as too extensive for operative help. Experience has taught the author that this is not always the case. Judicious operation to relieve tension and to drain, at least, with treatment of accessible lesions has given surprising and gratifying results. Immobilization may be subsequently induced by adhesive strips or a plaster of Paris bandage.

These indications are to be followed in the absence of symptoms of

brain disturbance. Their presence, as said above, demands exploration. By brain symptoms are meant exaltation or depression of mind, of sensation, of motion, or of special sense. It is particularly desired here to emphasize the fact that so-called "concussion" is as much an indication of brain disturbance as "compression," paralysis or spasm of a thumb is indicative of a hemiplegia or one-sided convulsion, and an extreme restlessness recently witnessed by the author was a more life-saving suggestion than a wild delirium. As

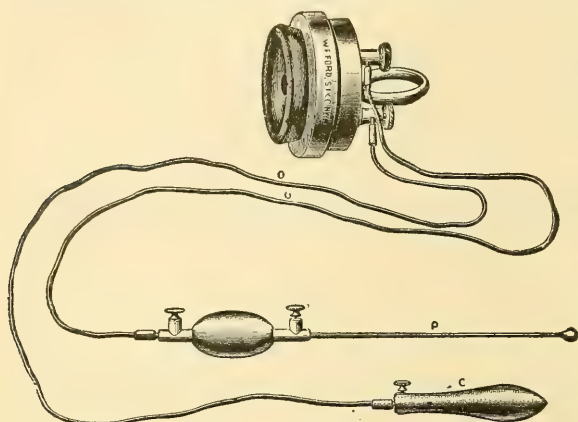


Fig. 453. Girdner's Telephone Bullet Probe.

bearing on the question of interference, persistence is the deciding point, and in deciding the meaning of persistence judgment is necessary. In the presence of moderate symptoms of, say, contusion, beginning to improve as soon as shock is over, no surgeon would think of interfering; but should these same mild symptoms persist they would strongly suggest surgical investigation. Exploration must be guided by external marks of injury and, in their absence, by localizing brain symptoms. Both being present, the latter must be followed, even if the two do not correspond, unless both are used. Inaccessibility of the region injured necessarily contra-indicates interference beyond attempts to relieve tension.

The treatment of wounds of the scalp has been already described (Page 661). The same principles apply to those made by the surgeon. It is well to first shave the entire scalp and to avoid the prolonged use of strong sublimate solutions, which sometimes produce eczema. In making such wounds for the exploration and treatment of fractures a flap is usually raised, including all the tissues down to the periosteum. For cosmetic reasons the resulting scar must be hidden as much as possible, the eyebrow, temporal fossa and hair border being sought for; in the hairy scalp no attention need be paid to this. Some operators advise that the base of the flap be below to ensure a better blood supply, dependent drainage being obtained by a counter-opening. Owing to the abundant vascular supply even this may be disregarded, access to lesions and drainage alone being considered. Starr, who first advised the use of the elastic tourniquet around the head, considers it useless.

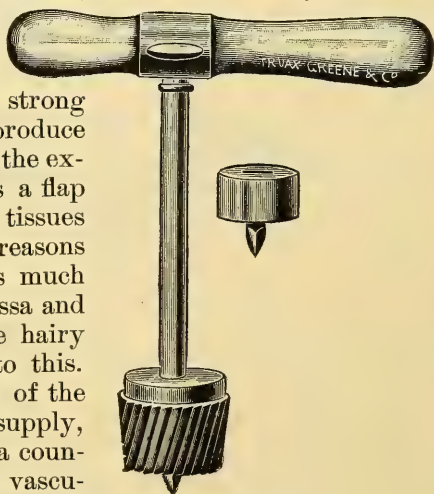


Fig. 454.  
Roberts' Trephine.

As an anesthetic chloroform is to be preferred, ether causing more



cerebral congestion; it is best administered by Northrop's method with oxygen. Some give a preliminary injection of sulphate of morphine; Grigsby finds that a spoonful of glycerine very slowly swallowed lessens the accumulation of mucus, thereby diminishing congestion, while two ounces of coffee taken before the above will have a similar effect in preventing the retching and vomiting of mucus and bile.

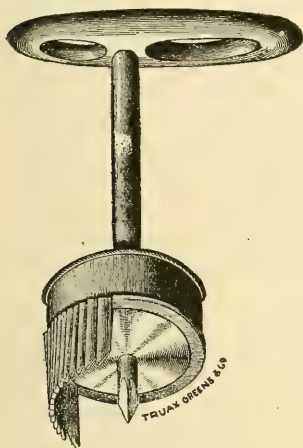


Fig. 455.

Roberts' Segmented Trephine.

An operation to open the skull is known as trephining, whether done by the circular saw, formerly termed the trepan, now the trephine, the chisel, the gouge, or the burr of the dental engine. As a rule an inch instrument is the one best adapted for general use, larger ones being undesirable on account of the expenditure of strength necessary to work them, and the danger of wounding the dura through inequalities in the thickness of the skull. The Roberts' trephine is easily kept clean and sterilized, while his segmented one is occasionally useful when the bone is of unequal thickness.

The trephine opening is readily enlarged by strong gouging or rongeur forceps. Two or more openings can be made and the intervening bone bitten away.

A fine gouge with a long stout handle is an excellent substitute for the trephine. It has been said that the jars of the mallet are undesirable, but the method which is extensively used in Germany seems to be gaining ground in this country. There is no mallet that can compare with the old fashioned potato masher (Fig. 556); it is easily sterilized and very cheap.

In a well equipped hospital a rotary saw worked by a dental engine or motor can be used; the dura must be carefully protected from injury.

In the presence of depressed or comminuted bone at least a part of the opening should be made in the intact skull; by leverage on the latter depressed fragments can be raised, while loose ones and, particularly, small spicules are picked out. The question of the removal of fragments which are partially attached requires judgment. In a general way, when in doubt they are best taken away. All sharp points or edges are trimmed off, as well as doubtful shreds of the soft parts. Trephine buttons and large pieces of bone should not be replaced. Occasionally by keeping them in physiological salt solution, in a water bath at a

temperature of about 100 degrees Fahrenheit, entire or chopped up into small bits, they have been successfully implanted. Or, instead of this recourse may be had to osteoplastic resection. An omega-shaped incision is made to the bone which is chiseled to the vitreous, except at the top and centre, where the inner plate is divided also. With an elevator



Fig. 456.

Potato-Masher Mallet,  
—Thomas.



the bone is raised, the base of the flap forming a hinge of soft parts and bone, and ensuring a vascular supply. Breaking the inner plate in this way forms a ledge which will prevent the flap from being depressed when finally replaced. Again, bony defects have been closed by decalcified bone, celluloid, bone from other patients or animals, or the outer plate of the adjoining skull. An absolutely aseptic after-course must be more than a pre-requisite.

The inner surface of the skull can be examined for quite a distance in every direction with the dural separator, which also has the use implied in its name. (Fig. 457.)

Extra-dural clots should be washed or gently picked out, the bleeding point, the middle meningeal usually, being reached by biting away the bone; it can be controlled by ligature, a stitch with a fine Hagedorn needle, a clamp, including the skull and left in place, or a gauze pack. The author has practiced the two latter methods; a severe hemorrhage, for instance, from the middle meningeal at its point of entrance was controlled by packing the foramen spinosum with gauze. It is worth noting that in spite of a bursting fracture, comminution of the entire temporal fossa with fissures radiating to the base, uninterrupted recovery followed without subsequent cerebral trouble. Hemorrhage from the diploë is occasionally troublesome; sponge pressure, packing with a pledget of gauze, or a mixture of wax, seven parts, oil, two parts, and carbolic acid, one part, will usually control it. A wounded sinus can be closed by hemostats which are left in place, double or lateral ligature, gauze pack in certain locations and, rarely, suture.

Dural wounds should be enlarged to examine the underlying parts. When this membrane is opened the incision should run at least a quarter of an inch from the bone and a flap be raised; it is first nicked with a scalpel, then picked up on a tenaculum and divided with blunt-pointed scissors. Care should be taken to separate adhesions, or troublesome hemorrhage from the vessels of the pia will result. The opening is accurately closed with a continuous suture of fine sheep-gut. Dural defects have been successfully closed by transplanting inverted pieces of the pericranium, and sterilized gold-foil has also been placed under a sutured wound to prevent adhesions between the dura and brain.

Fig. 457.  
Horsley's Dural  
Separator.



The finger can explore the surface of the brain for some distance in every direction, the differences in density affording valuable information. Bulging of the brain, showing increased intracranial tension, and absence of pulsation, which points to clot, cyst, tumor or abscess, are also to be noted. The substance of the brain can be examined with a grooved director or by incision, the latter in the lateral regions being longitudinal rather than vertical, so as not to invade more than one set of centres. So, too, the summit of a convolution should be entered, as less bleeding will

be caused. Hemorrhage from the pial vessels may be treated by pressure with a sponge, or a clip or gentle ligature with fine sheep-gut; they are very friable. Cocaine has been used for oozing from the brain substance, but the bleeding is apt to be greater when its effects pass off; greater, therefore, when the wound is closed. Temporary pressure usually suffices; otherwise the pack is necessary. Sub-dural or cerebral drainage is accomplished by the tube, a roll of Lister protective, or a strip of gauze. In all doubtful cases the gauze pack for forty-eight hours and a secondary suture should be employed. This is imperative if a cavity exists in the brain. Hernia cerebri is the danger, and usually occurs through a small opening and in an infected wound. If suture is postponed too long retraction of the scalp will prevent accurate closure.

Fractures of the base require a word of separate mention, what has been said above applying as well to operated cases here. Efforts should be directed principally to rendering aseptic the cavities through which communication between the fracture and the outside air takes place. This is comparatively easy in the ear, which can be washed out with sublimate, the drum-head being previously incised if it is intact, when the middle-ear is seen to be full of blood. The canal is then packed with bichloride gauze. Fractures opening into the nose and pharynx are less asepticable; at most, solutions such as Thiersch's can be used, and antiseptic occlusion is necessarily imperfect. Even these clumsy attempts at asepsis have improved the results wonderfully. Brain symptoms should lead us, however, to go still farther; with localizing symptoms, a bruise or a fissure as guides, the skull should be opened at least to relieve tension, or to gently raise the brain and disinfect or drain the region of the fracture. The author is convinced that such a course has saved more than one life.

The general treatment of cranial fractures is that of brain injuries. Rest, both bodily and mental, a darkened room, no noise, no odors, no company and no mental effort for three or four weeks. Cold to the head and heat to the feet may benefit. From their pathogeneses such remedies as arnica, belladonna, gelsemium, hyoscyamus, stramonium, opium and others will readily suggest themselves. For stimulation ammonia is preferable to alcohol, as it does not produce cerebral hyperemia. So, too, bromide is better than morphia as an anodyne. The bladder should be looked to at once, retention calling for the regular use of a strictly sterilized catheter, remembering the maxim that frequent urination means retention. Even with involuntary urination it is well to exclude overflow occasionally. Cystitis calls for washing. The bowels should be kept open, once a day at least, with laxatives. Such cases must be watched for a long time. Surroundings, company and occupation need careful attention. General massage or careful exercise, avoiding the sun and overheating, will improve nutrition. Alcohol is to be particularly forbidden. Strychnia, in some form, is useful after any injury or operation producing a profound mental impression.

### CHAPTER III.

## THE SKULL—DISEASES.

**Inflammations of the Skull.**—These are periostitis or osteitis, as elsewhere, often with resulting caries or necrosis, and the processes are the same as in other bones. An acute periostitis may follow an injury or have no apparent cause.

**PERIOSTITIS.** The presence of pyogenic micro-organisms will be shown by pus; this is met with in connection with unclean wounds, or by infection from within, as in the subperiosteal mastoid abscess. Occasionally a localized suppurative periostitis occurs as a sequel of typhoid and other infectious diseases. The chronic form is most frequently syphilitic—a gumma—which is apt to involve the underlying bone also. Again, a traumatic or syphilitic periostitis is met with which tends to ossify, forming nodes. Probably the tenderness of the scalp in the early secondary stage is due to a periosteal inflammation. Tubercular periostitis will result in the characteristic cold abscess, usually with an associated caries, which is considered pathognomic. It is met with, as elsewhere, in cachectic children.

*Treatment.* This must depend on the cause. In the acute suppurative variety early and free incision and disinfection; in the tubercular and cold abscess, evacuation, curettement and local and general anti-tubercular treatment. The early nodes of syphilis are controlled by mercury, the later lesions by iodide of potash, assisted at times by incision and cleaning out.

**OSTEITIS.** Osteitis may, in like manner, be acute or chronic. The former follows infected injuries mostly, and was formerly often seen in compound fractures, being an osteomyelitis from involvement of the diploë. Venous thrombosis from this source is not uncommon; the clots loosen or break down, are carried into and infect the sinuses, or as metastatic emboli produce a pyemia. Such complications are indicated by rigors. Necrosis, at times of considerable extent, may follow, and may also be produced by the direct effects of traumatism. The chronic form is well named. Rarely, it may originate in an injury, when a rarefying osteitis will be established, by means of which small or large pieces of bone will become separated. In the former case the sequestra will come from the external table; in the latter the entire thickness of the skull will be involved. Much more frequently syphilis is the



Fig. 458.  
Syphilis of Frontal Bone, with Loss  
of Substance.—Vischer.



exciting cause, and it may destroy the skull very extensively and in more places than one. When the bone comes away the pulsating dura will be seen covered with granulations. General meningeal infection, strange to say, rarely results.

*Treatment.* It may be impossible to distinguish osteomyelitis from suppurative periostitis or a phlegmon of the scalp. Early incision, however, is equally demanded in all three. The inflamed bone must be exposed and removed with gouge or trephine to get at the diploë and the extra-dural space; all diseased tissue must be scraped or excised, and the most energetic disinfection with carbolic acid and sublimate practiced. The chronic form does not require such haste. Anti-syphilitic treatment will exercise a marked influence when indicated. Abscesses are to be opened and cleaned, necrotic bone removed when loose, and carious cavities scraped. Frequent dressings are needed, as the odor is very disagreeable.

**Atrophy of the Skull.**—The cranial bones may become thinned or even perforated. When general this is met with in the aged and appears to be a senile change. Both tables are usually affected, although the atrophy may be confined to the outer. The compact bone suffers most, the skull becoming soft. A kindred condition of osteoporosis has been met with without thinning. Translucency has been noticed. Protection from injury is about all that can be done for such cases. When localized, atrophy is due to pressure from tumors, Pacchionian granulations, vessels, intracranial tension—as from hydrocephalus. In early life a form known as craniotabes is more frequently met with, which is ascribed by some to hereditary syphilis, by more to rickets. As a result the skull has a parchment-like feel, while from pressure in the recumbent position the back part of the head becomes flattened. Convolutions of the brain may be marked on the bone. The fontanels are slow in closing and their edges and those of the ununited sutures are thickened. Other rickety lesions are often found in the skeleton.

**TREATMENT.** If there are manifestations of hereditary syphilis specific medication must be added; aside from this the treatment is essentially that of rickets—the lime preparations, cod liver oil, nourishing, easily assimilated diet, good surroundings and hygiene. Such children must be protected from falls, blows, etc.

**Hypertrophy of the Skull.**—There may be a true overgrowth, both tables and the diploë being alike affected, or, more frequently, the bone becomes condensed and ivory-like at the expense of the diploë. The author has met with both thickening and condensation of the entire skull in an old syphilitic. He was a great sufferer from headaches. Syphilis and osteitis deformans are the supposed causes of the later form, which is also known as hyperostosis.

Treatment will not avail and the condition cannot be recognized during life.

**Tumors of the Skull.**—**OSTEOMATA.** This class of tumors is characterized by their slow growth. Most frequently they are known as exostoses when external, and enostoses when internal, or springing from the diploë. Their position is between tumors, hypertrophy and inflammatory growths. Exostoses may be cancellous or compact, more frequently the latter, especially when they have existed some time. They are globular, with a broad base, usually, and may attain considerable size.

They are met with most frequently in the orbit, also in the roof of the nose or frontal sinus, the vault and the base. Enostoses are usually inflammatory and are caused by injury or chronic inflammation, being met with, too, in pregnant women and alcoholics. They may spring from the inner plate or the dura.

*Treatment.* If in a bony sinus, in the orbit, or in the nose, and accessible, these growths should be removed. The chisel and mallet are necessary. The growths may be located internally by pressure symptoms, and removed with the overlying bone. When on the vault, operation is undertaken if they are annoying or unsightly, and if easily carried out.

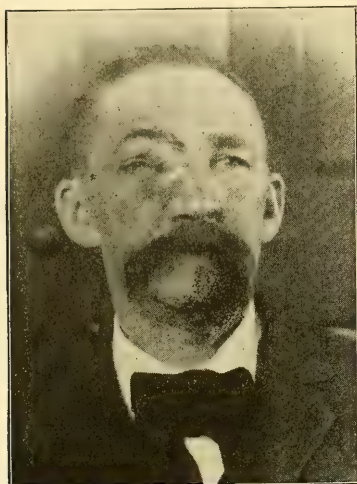


Fig. 459.

Sarcoma Originating in Right Frontal Sinus.

resorption of bone and appear externally. These growths are of the spindle-celled and, occasionally, of the giant-celled varieties. Degenerations, such as the myxomatous, calcification and cysts, are common. They are not movable with the scalp, usually grow rapidly, and may be quite painful. Diminution in size from continuous pressure has led to the diagnosis of vascular tumor. Those springing from the dura may be reduced and the bony opening of exit recognized; pulsation will also be felt. Those causing atrophy of the outer table may give the well-known egg-shell crackling.

Symptoms of brain pressure will be present when the tumor grows internally, and they may be induced by reducing a protruding growth. Compression of special nerves or organs will produce corresponding symptoms.

*Treatment.* This must needs be early and complete. Not soft parts, bone, nor dura should be spared in the effort to be thorough. The diagnosis is usually made too late. Recidives are common and the external growths are sometimes multiple. The great

**SARCOMATA.** Sarcomata may spring from the pericranium, when they rarely involve the underlying bone, but grow outward, at times attaining great size. More frequently they originate in the diploë, separate the two plates of the skull until one of them gives way, when the growth spreads out under the scalp or compresses the dura and brain. Again, those of the dura will grow mostly towards the brain, although if between this membrane and the skull they may cause

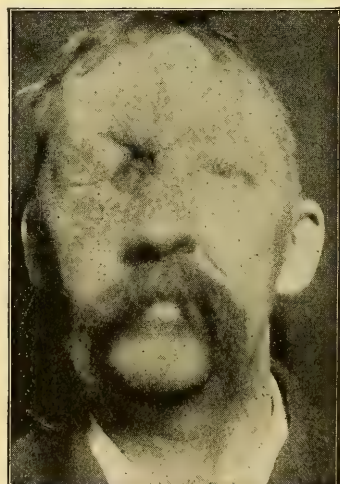


Fig. 460.

Result After Dissecting Frontal Sinus and Adjoining Portions of Frontal Bone, Cleaning out the Orbit and Removing most of Upper Jaw.—Van Lennep.



dangers are shock, particularly with the deeper growths, hernia cerebri when the dura is attacked, and recurrence.

The author has succeeded in carrying a patient through the first two dangers by operating in several sittings, and closing the dura by periosteal transplantation and the scalp defect by a plastic operation. Nearly two inches of the superior longitudinal sinus required resection.

**Microcephalus.**—As the name implies this is a condition in which the head is small, and with this is associated imbecility, idiocy and other manifestations of intracranial defect, irritation, or pressure. This comparatively new field is, as might be expected, not yet fully understood, and one concerning which there is a considerable difference of opinion. Some claim that the results of surgical intervention are magical, others that they are useless. It is to be inferred from this that cases must vary in their causation and pathology. The small head and accompanying imbecility have been attributed solely to premature union of sutures; the cause, however, is more frequently intracranial, the small skull being the result. Such changes may be brought about by injuries producing inflammation or hemorrhage, disease of the blood vessels, imperfect cerebral development, etc. That pressure is exerted at times is shown by the observation that pulsation which was absent soon appears after removing the bone. The author has also met with an excess of sub-dural fluid, an external hydrocephalus, the careful withdrawal of which was followed by pulsation and temporary collapse of the brain. Almost all the primary results of operative interference have been brilliant, the child, at times, seeming to come out of a trance. The improvement soon stops, however, if nothing further is done, and long continued, careful instruction by those experienced in the care of the feeble-minded must be insisted on. The author refuses to operate unless subsequent education of this kind is guaranteed. The great danger is shock, and this increases with the duration of the operation. It is obviated by quick work, not more than fifteen or twenty minutes being consumed, and by operating in several sittings.

**OPERATION.** This consists, essentially, in removing strips or pieces of bone to lessen tension and allow of expansion—craniotomy or craniectomy. When the microcephaly is symmetrical two strips of bone are removed from above the frontal sinuses to the tentorium on either side of the middle line. Strips can be removed laterally at right angles to these, at either end and at the middle, or they can be united at the vertex to form an H. The skull is first opened with a trephine from which the bone is quickly bitten away with rongeur forceps. By working first one side and then the other the instrument will not get locked in the opening. Ossification will be prevented by removing a strip over half an inch wide.

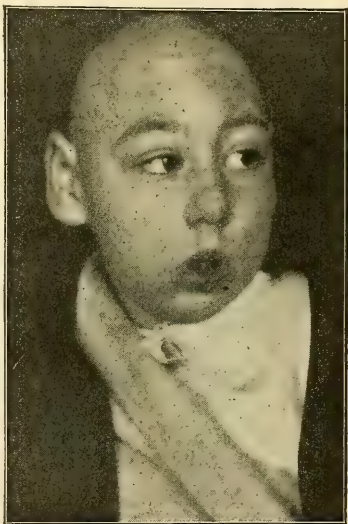


Fig. 461.  
Microcephalic Idiot.



An aseptic wound is absolutely essential. Among five cases operated by the author prehensile power and that of locomotion have been restored,

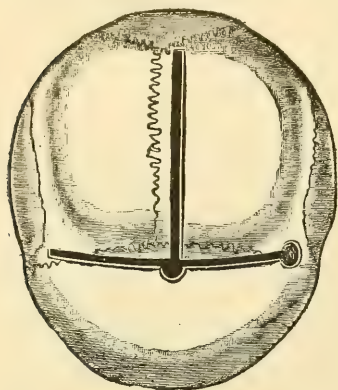


Fig. 462.

"T" Incision for Microcephalus.

objects have been followed, recognized and named — when previously an approaching blow was not noticed—and instead of barking like a dog nursery rhymes have been learned, even during the period of wound-healing. Subsequent improvement under instruction has been noted, although in a less striking degree. When the lack of development is unequal or when the symptoms point to a certain portion of the brain, as the motor centres, for instance, the operative attack should be directed accordingly. The strip removed may then be curved or V-shaped, or a considerable flap of bone may be raised or removed. At times the whole vertex has been loosened by circular craniotomy.

**Cephalocele.**—It may not be out of place before leaving the skull to consider the protrusions of its contents which may take place through its defects.

Cephaloceles, or *herniæ cerebri*, are of congenital origin and may appear at portions of the skull corresponding to the different ventricles, or the cornua of the lateral. They will be found, in the order of their frequency, at the back of the head (fourth ventricle), where they are known as occipital; above the root of the nose, on either side of the middle line (anterior cornua), termed, in contradistinction, sincipital; back of the mastoid (posterior cornua), or in the pharynx (third ventricle). The last two are very rare, as are those exceptionally met with in other locations. Developmental defects of the head or of other portions of the body are apt to be associated. Attempts at reduction cause pressure-symptoms, but, when sufficiently replaced, the bony defect can be felt. Pulsations are often noticed, and the tumor grows tense when the child coughs, cries, or strains.

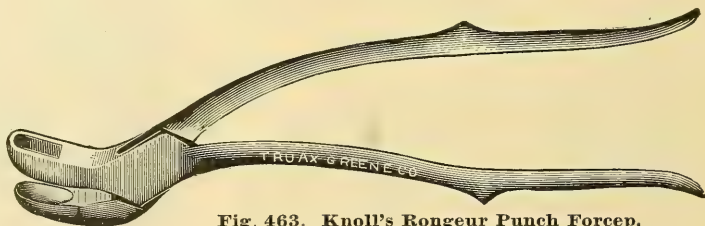


Fig. 463. Knoll's Rongeur Punch Forcep.

**VARIETIES.** Cephaloceles may contain the dura and some fluid, when they are known as meningoceles; or the membranes and brain substance, when they are termed encephaloceles. Hydrencephaloceles are made up of membranes, brain substance and fluid within the latter, in a dilated ventricle or communicating with one. Meningoceles are usually small, fluctuating, translucent, pedunculated, non-pulsatile, reducible, and enlarge from increased intracranial tension. Encephaloceles are also usually small, but non-fluctuating, opaque, sessile, pulsate, become larger from coughing or straining, and produce symptoms when reduced, reduction being done with difficulty.

**DIAGNOSIS.** Differentiation, particularly when sincipital, from congenital vascular growths is, at times, very difficult, owing to the red, vascular skin covering them both. Hydrencephalocoeles are apt to be large, fluctuating, more or less translucent, pedunculated and lobulated; non-

pulsatile, irreducible, uninfluenced by intracranial tension, and associated with imperfect development of the head.

**PROGNOSIS.** Children with encephalocoele of any size, and hydrencephalocoele in particular, rarely live long. Small encephalocoeles and meningoceles, when covered by healthy skin, may not interfere with life;



Fig. 464. Congenital Prolapsus Cerebri.—Cutter.

the bony opening in the latter may even close, making the cyst extracranial. The great danger is rupture, with consequent purulent meningitis.

**TREATMENT.** This should, above all, aim at preventing rupture, and, should this occur, at excluding infection by protective as well as sterile or antiseptic absorbent dressings. Excision has been successfully practiced and is to be recommended in suitable cases. Aseptic tapping, followed by compression, has proved safer, and, on the whole, more satisfactory. Injections are to be deprecated. Electrolysis is not dangerous but of questionable value.

**Prolapsus Cerebri.**—This condition, known also as hernia or fungus cerebri, consists essentially of a protrusion of the brain through an opening in the dura, skull and scalp. Its presence usually presupposes an incision into or excision of brain substance; also wound-sepsis—intracranial tension being increased and abscess often co-existing underneath. Such prolapse is, strange to say, more apt to occur through small than large defects. It is usually met with on the vault and sides of the head, although instances are recorded in which it has appeared through the ear, or through wounds of the base. The protrusion consists largely of granulation tissue, edematous from constriction, although the brain substance may be forced out until a ventricle is opened. The mass is dirty brown in color, discharges pus, bleeds when touched, and pulsates. Such prolapses grow rapidly at first; then



Fig. 465.  
Fungus Cerebri from Accident—  
Amputation—Recurrence—  
Death—Parker.

slowly, until they come to a standstill, at times attaining the size even of a fist; they may then gradually shrivel or slough off, recede and cicatrize, a marked depression indicating their former site. The great danger is spreading septic inflammation of the meninges or brain.

TREATMENT. Pressure usually causes cerebral symptoms; excision is followed by recurrence—hence there is nothing left but protection. To this must be added what is of still greater importance, the induction of asepsis by frequent antiseptic dressings. Abscess should be borne in mind and looked for if suspected. Cicatrization, when beginning, should be encouraged and hastened by skin grafting. Prolapsus cerebri is best prevented by an aseptic condition of the brain, accurate closure of the dura by suture or transplanted pericranium, and primary union of the scalp wound.



## CHAPTER IV.

### CRANIAL TOPOGRAPHY.

**Bony Landmarks.**—The structure and elasticity of the cranial bones, the increase of the latter by the sutures and the arched arrangement of the skull, with its buttresses, have already been referred to. There are several points in the topography of the cranium that require mention.

The principal sutures are the coronal, or fronto-parietal, the sagittal, or inter-parietal, lambdoidal, or occipito-parietal, and the squamo-parietal,

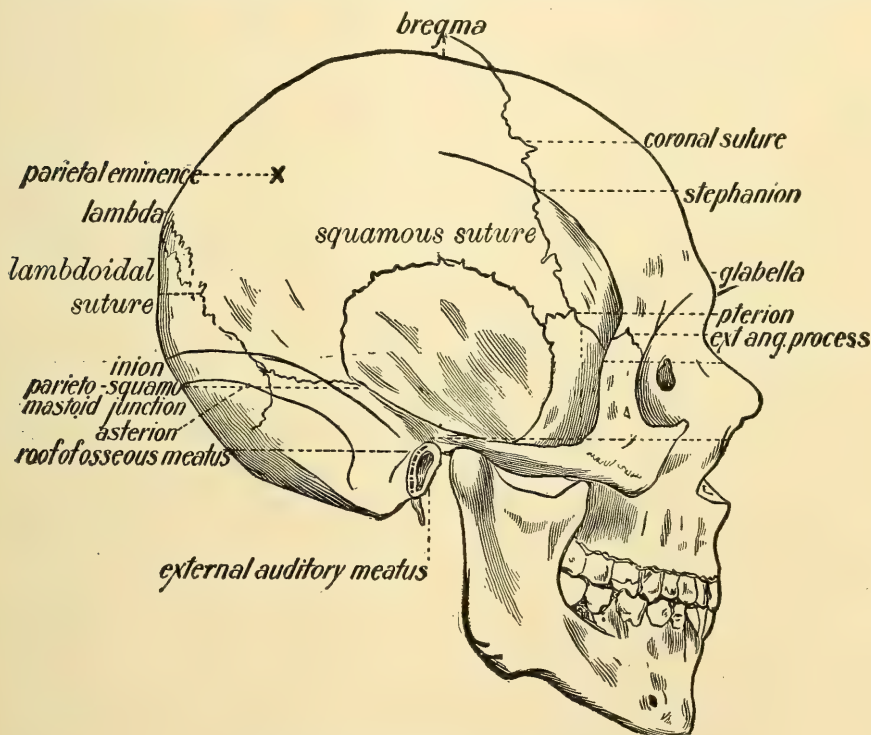


Fig. 466. Location of Bony Landmarks.

or squamous. It is well to bear in mind the overlapping character of the last named as distinguished from the dentations of the others; also the frequent presence of Wormian bones in the lambdoidal suture, as well as the fact that the sagittal may occasionally be continued to the root of the nose. Besides these there are the speno-parietal, the frontal, the squamo-sphenoidal and the masto-parietal and occipital. In disease originating in the ear the masto- and petro-squamosal sutures must also be remembered. In children they are ununited and this condition may persist through life.

There are certain landmarks or lines which are used to locate points in or under the bone.

The glabella is the smooth prominence over the root of the nose between the eyebrows; the inion is the external occipital protuberance. The external angular process of the frontal bone where it articulates with the frontal process of the malar is easily found. By the parietal eminence is meant the most prominent part of the boss on the surface of this bone. To locate a point accurately on a level with another it is well to have a base line; the so-called Reid's base line is one drawn from the lower margin of the orbit through the external auditory meatus to just below the inion. This is used by some surgeons in locating the fissures. The pterion is the junction of the squamous, sphenoid, frontal and parietal bones, which form an H or K. The bregma is the point at which the sagittal touches the coronal suture. A line drawn over the head joining the external auditory meatus of either side, the bi-auricular line, will pass just behind the bregma. The other end of the sagittal suture, where it touches the lambdoidal, is known as the  $\lambda$ . By the external auditory meatus is meant the centre of this opening. The roof of the osseous meatus is also a landmark. The asterion is the junction of the mastoid, parietal and occipital bones; anterior to it is the parieto-squamo-mastoid junction. A line from the inion to the asterion marks the middle of the first part of the groove for the lateral sinus; one from the latter to the roof of the osseous meatus marks the sigmoid groove to its knee; one from the parieto-squamo-mastoid junction to the tip of the mastoid marks the remainder. The uses made of these landmarks will be explained in treating of the brain and its lesions.

**Membranes.**—The dura mater serves the double purpose of an internal periosteum of the skull and a covering for the brain, its inner surface being lined with endothelium. It is loosely attached to the bone in the convexity, sides and back except at the sutures, but at the base it accompanies the nerves and becomes continuous with the pericranium through the different foramina. Should there exist any space between the dura and the skull it would be termed *epi-dural*; that between it and the arachnoid is termed the *sub-dural* space and contains some cerebro-spinal fluid. This communicates with the same potential cavity in the spinal canal and with the lymph spaces in the nerve sheaths throughout their course.

The arachnoid is closely adherent to the pia, but does not dip into the sulci with it, and is widely separated from it at the base. The space thus formed is known as the *sub-arachnoid*, contains the greater part of the cerebro-spinal fluid and forms, in the last named location, the water-bed of the brain where it is most needed. Communication exists between the sub-arachnoid space of the brain and that of the spine, and with the ventricles through the foramen of Magendie; also with the nerve sheaths, the optic throughout its course and the others for a short distance.

The pia mater is the vascular membrane. Its connection with the brain substance by the branches that dip into the latter is so intimate that inflammation of the one must involve the other.

**Cerebral Localization.**—**TOPOGRAPHY OF THE BRAIN SURFACE.** The cortex, of the greatest interest to the surgeon, is divided into lobes and lobules, convolutions and gyri, fissures and sulci. In the study of the deeper portions the white matter and the basal ganglia have a

rather negative value, it being desirable to exclude their lesions on account of their inaccessibility before undertaking surgical measures.

**FISSURES.** The longitudinal or median fissure divides the cerebrum into two halves. It is located by a line drawn from the glabella to the inion or by the sagittal suture, but is slightly to the right of these in right-handed and to the left in left-handed individuals; it contains the falx cerebri and corresponds with the position of the superior longitudinal sinus.

The fissure of Bichat separates the cerebrum from the cerebellum, contains the tentorium and approximately marks the first part of the course of the lateral sinus. Its location corresponds to a line drawn from the inion to either auditory meatus.

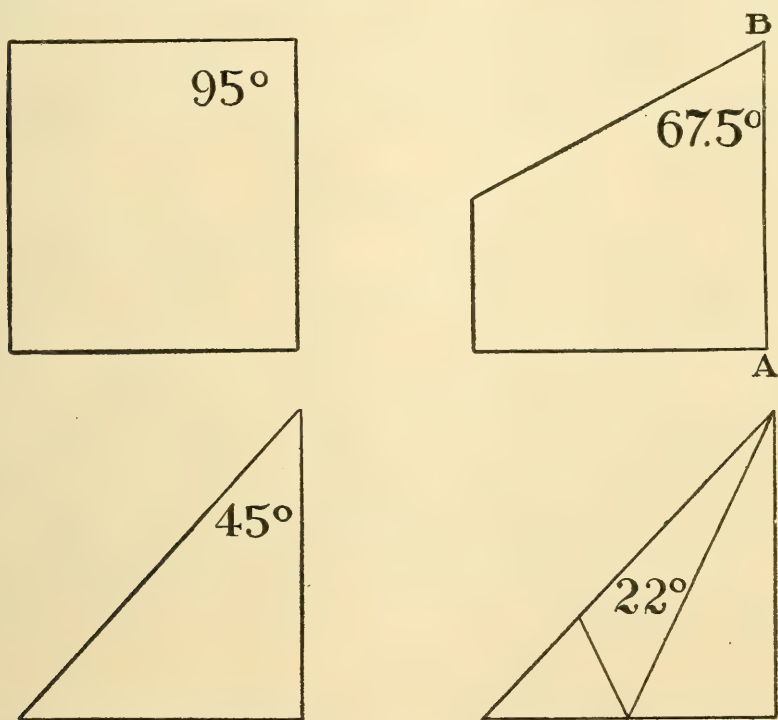


Fig. 467. A B is Applied from Before Backward to the Median Line.

The fissure of Rolando begins a short distance outside of the median, just back of its centre, and runs downward and forward at an angle of sixty-seven and a half degrees for three and three-eighths inches. Its lower third is slightly more vertical and it points to but does not reach the angle between the anterior and posterior limbs of the fissure of Sylvius. The portion included in this angle and around the end of the fissure of Rolando is known as the operculum. The fissure is found by laying a tape measure from the glabella to the inion and taking a point 55.7 per cent. of this distance backward. Practically, this point is a half inch back of the middle. The angle sixty-seven and a half degrees with the median line can be measured with the graduated arc found in any school set of geometrical instruments. If this is not at hand a square of



paper can be used as indicated in Fig. 467. Several instruments known as cyrtometers have been devised for the purpose of locating the fissure but the above simple methods are to be preferred. A sterilized piece of protective can be substituted for the paper.

The fissure of Sylvius starts between the frontal and temporo-sphenoidal lobes and runs upward and backward for about four inches. Three quarters of an inch from its anterior extremity is its vertical branch, which runs directly upward for a half inch or more. Lying within the fissure and hidden by the operculum is the island of Reil, which consists of several small convolutions. The fissure is found by taking a point an inch and a quarter behind and on a level with the external angular process, and another three-quarters of an inch below the parietal eminence. A line between these two points will correspond with the horizontal limb, and by going out three-quarters of an inch on this line the origin of the vertical limb can be found. The point of bifurcation is said to be beneath the pterion. The course of the latter limb is parallel to the squamo-sphenoidal suture.

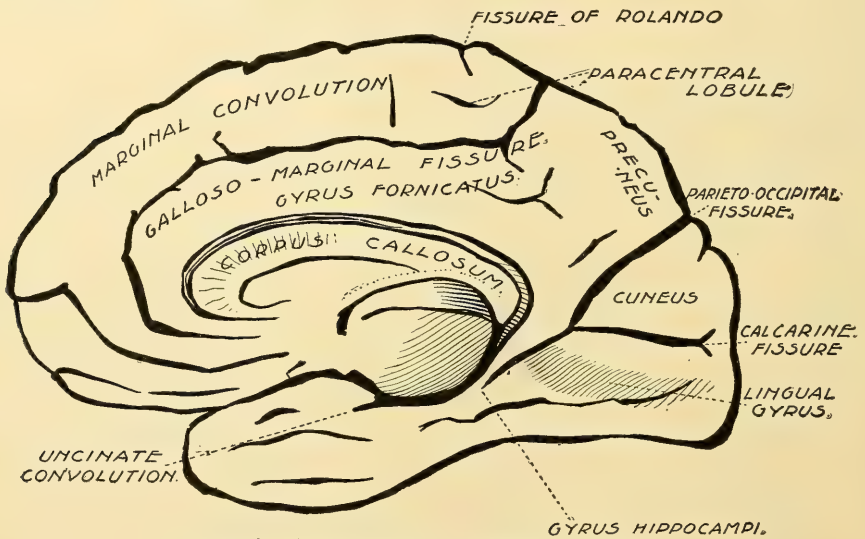


Fig. 468. Inner Surface of Right Hemisphere.

The parieto-occipital fissure appears as a notch on the convexity of the brain, midway between the upper end of the fissure of Rolando and the fissure of Bichat. On the median surface it runs downward and forward to meet the calcarine fissure, these two forming the sides of a triangle of the brain known as the cuneus. The notch is found by prolonging the line corresponding to the horizontal limb of the fissure of Sylvius to the sagittal suture. Most of the cerebral areas open to surgical operation can be located by their relations to these three fissures—the Rolandic, Sylvian and parieto-occipital. Two others deserve mention. The calcarine fissure begins in front of the lower anterior end of the parieto-occipital and runs directly backward toward a point midway between the latter and the base of the brain. It is on the median surface and does not appear on the convexity. The calloso-marginal fissure starts behind the fissure of Rolando and runs downward and then forward on the median

surface, midway between the upper margin of the brain and the corpus callosum, around the anterior end of which it curves. The portion between the upper posterior part of the calloso-marginal fissure and the parieto-occipital is known as the precuneus or quadrate lobule.

**LOBES.** The frontal lobes are anterior to the fissure of Rolando; the parietal, between the Sylvian, Rolandic and parieto-occipital fissures; the occipital, behind the last named, and the temporo-sphenoidal below the fissure of Sylvius.

**CONVOLUTIONS.** The most important convolutions are those on either side of the fissure of Rolando, the ascending frontal or pre-Rolandic and the ascending parietal or post-Rolandic. They are continued on the median aspect of the cerebrum above and in front of the calloso-marginal fissure to constitute the paracentral lobule. In front of the ascending frontal convolution is the pre-central or vertical sulcus which runs parallel to and just behind the coronal suture and separates the pre-

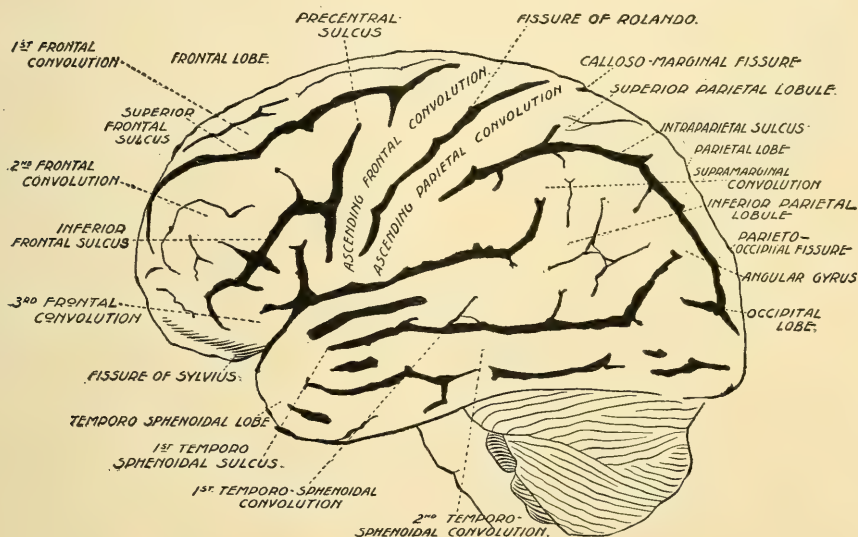


Fig. 469. Outer Surface of Left Hemisphere.

Rolandic from the frontal convolutions. Of these there are three, the first, second and third, or superior, middle and inferior, running from below upward and separated by the superior and inferior frontal sulcus; the latter sometimes joins the pre-central at a varying angle and is said to be on a level with the stephanion. Behind the post-Rolandic convolution is the intra-parietal sulcus which, starting between the Rolandic and Sylvian fissures, in its upward course widens the above mentioned convolution into what is known as the superior parietal lobule. It then runs directly backward and finally downward into the occipital lobe, forming the upper boundary of the inferior parietal lobule. The supra-marginal convolution lies at the posterior extremity of the fissure of Sylvius, while the angular gyrus begins in the first temporo-sphenoidal convolution and winds around the end of the first temporo-sphenoidal sulcus, also known as the parallel fissure, to join the second convolution of this lobe. The temporo-

sphenoidal convolutions are two or three in number, divided, accordingly, by one or two sulci. They run parallel with the fissure of Sylvius which is the upper boundary of the lobe, and are numbered from above downward.

The marginal convolution is on the median aspect of the brain above the callosal-marginal fissure; below the latter is the gyrus fornicatus, also known as the convolution of the corpus callosum, around which it winds,

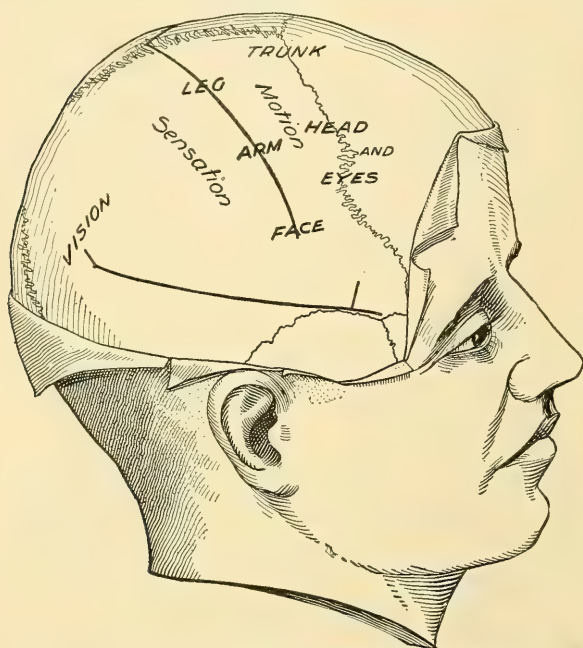


Fig. 470. Cerebral Localization Right Hemisphere.—After Starr.

front and back. Extending from its posterior end into the temporo-sphenoidal lobe is the gyrus hippocampi, and beyond this the uncinate or hooked convolution. The lingual gyrus lies below the calcarine fissure.

**AREAS.** There are certain areas of the brain the functions of which are well understood, while lesions of others cannot be recognized. The latter have been termed the silent areas and are quite extensive. The right hemisphere in right-handed individuals is less developed and has fewer recognized cortical centres

than the left. The frontal lobes, too, particularly their under surface, belong to this class, for while they are known to have a relation to the higher mental processes they may be extensively diseased without producing definite symptoms; this is especially the case where one side is affected, the other compensating. Occasionally mental dulness, inattention, inability to concentrate thought or loss of self-control, has accompanied their lesions. It should be remembered in considering the different centres that they are not clean-cut, but merge the one into the other, their controlling power shading off, as it were, from a focus of greatest intensity. Thus it is that the excision of a centre produces incomplete or temporary paralysis. Besides this over-lapping of centres the brain has compensatory possibilities. For example, when the speech centres which are unilateral are destroyed the other side of the brain can be educated to do the work. It would seem, then, that there are some reserve areas as well.

**Motor Area.** The motor area of the cortex consists of the pre- and post-Rolandic convolutions, the upper portion of the first frontal convolution and the superior parietal and paracentral lobules. This area on one side of the brain controls movement of the opposite side of the body. From above downward, in a general way, the body may be said to be inverted; thus, first come the centres for the lower, then for the upper



extremity and finally for the face. In each section, again, there seems to be a return to the normal order, e.g., shoulder, arm, hand and fingers. The uppermost portion of this area governs motion in the lower extremity and is known as the leg centre. Beginning in front and going backward and slightly downward, are the centres for the hip, thigh, knee, leg, ankle, great toe and the smaller ones in the order named, in the frontal, pre- and post-Rolandic convolutions, the superior parietal and paracentral lobules. The centres for the trunk are thought to be on the median surface anterior to the paracentral lobules. Movements of the upper extremity are controlled by the middle half of the motor area, the arm centre, the shoulder above and in front, then the elbow and, lastly, the wrist, fingers and thumb below and behind. The face centres occupy the inferior portion; those for the eye-brows and cheek above and in front; those for the tongue and larynx below and in front; those for the mouth, pharynx and platysma behind. The centres governing movements of

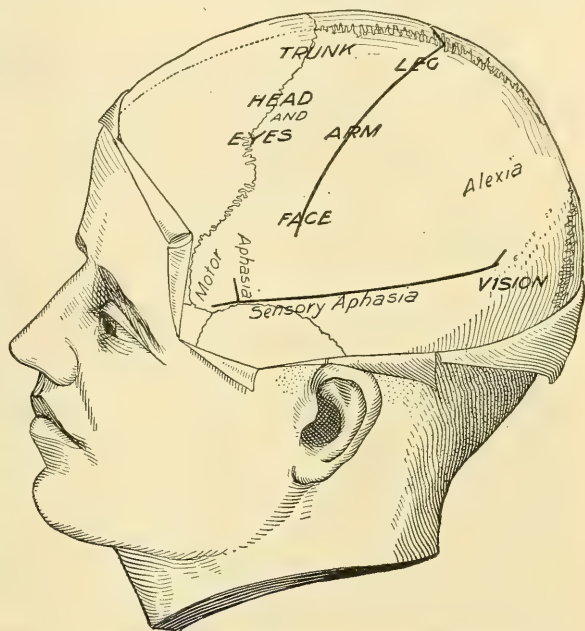


Fig. 471. Cerebral Localization Left Hemisphere.—After Starr.

the head and eyes are supposed to be in the second frontal convolution. Lesions of the motor area will produce paralysis or spasm according as they are destructive or irritative. The former correspond strictly to the lesion; the latter may spread from the lesion as a focus to parts controlled by adjacent centres. The more localized the convulsion and the closer the resemblance of recurrences to the original spasm the greater is the certainty that the cause is the cortex.

*Sensory Area.* The sensory area is still in doubt, but is probably the same as the motor, particularly the ascending parietal convolution.

*Speech Areas.* The areas of speech are on the left side in right-handed individuals and vice versa. They are of four kinds, two sensory or receptive and two motor or emissive. Of the two sensory, auditory speech, or the power of understanding articulate word sounds, has its area in the posterior part of the first and perhaps second temporo-sphenoidal convolutions; that for visual speech, or the power of understanding written or printed language, is in the angular gyrus. The other two are motor speech, or the power of coördinating the muscles of phonation so as to articulate words, which has its area in the base of the third frontal convolution and the adjacent portion of the pre-Rolandic (Broca's centre);

and written speech, or the power of writing, which originates in the same region and is connected with the arm centre by association fibres.

Lesions of the speech areas will produce, according to the portion affected, the different forms of aphasia, which is a general term applied to loss of speech of cerebral origin, as distinguished from that of laryngeal or muscular. Motor aphasia, or aphemia, results from disturbances of the motor speech centres. So does agraphia or the loss of the power of writing from dictation or copying. Of the sensory aphasias there are word deafness, or the inability to understand words that are heard, sounds being perfectly heard, and word blindness, or alexia. A variety of motor aphasia is known as amnesic, that is, words are forgotten. It is supposed to be due to disease of the island of Reil. Another form is amimia, or loss of gesture power; still another is paraphasia, or the use of another word than the one intended. Apraxia is applied to the inability to recognize the nature and uses of things seen, heard, touched, smelled and tasted.

*Visual Areas.* The visual area of the cortex is in the cuneus and the convexity of the occipital lobe, each side containing the sight centres for the corresponding half of both retinae. A lesion in this region will produce hemianopsia, or blindness of one-half of the visual field on the opposite side of both eyes. There is another visual centre in the angular gyrus, while one for the upper lid is also said to be located in this convolution.

In this connection it may not be out of place to consider a little more in detail the symptom of hemianopsia which indicates lesions in the optic commissure or tracts as well as in cortical the visual centres. Hemianopsia may be uni- or bi-lateral according as it affects the half fields of one or both eyes; vertical or horizontal, according to the direction of the dividing line between the blind and normal fields, but this line may be oblique or irregular, nasal or temporal, according to the side of the eye blinded; binasal or bi-temporal, when one of the above is present in both eyes; homonymous, when the nasal field on one side and the temporal on the other are blind, right and left being added to indicate the blind side of the patient. Recalling the anatomy of the visual tracts, there are the cortical centres in the occipital lobe already referred to, the primary centres in each optic thalamus, external geniculate and anterior quadrigeminal bodies, the optic tract, the optic chiasm with its direct and decussating fibres and, finally, the nerve. Plate XVI, Fig. 2.

**RESULTS OF LESIONS.**—The results of lesions will vary according to their location. If in the occipital lobe hemianopsia alone will be produced—this is the important surgical fact; if in the ganglia hemianesthesia will be associated with it; when the internal capsule is involved hemiplegia will be added to the above. Those between the ganglia and chiasm cause hemianopsia and loss of pupillary reaction to light thrown on the blind half of the retina, the half blindness being in the opposite halves in lesion of the optic tract. It should be remembered that as the rays of light cross on entering the eye the blind half is the opposite of the half of the retina affected. If in the chiasm, and the outer or direct fibres are involved, the nasal variety results in the eye of the same side, while the bi-temporal form points to the central portion—that is, the decussating fibres. Involvement of the last named fibres, together with the direct on one side, will produce complete blindness in the eye corresponding with the latter, and temporal hemianopsia in the other. These are the typical varieties, while irregular forms are common.



*Olfactory Area.* The sense of smell has its cortical centre at the tip of the temporo-sphenoidal lobe in the uncinate convolution; that of taste in the lingual gyrus, while that of sound, the auditory sense, is in the posterior portion of the first and second temporo-sphenoidal convolutions. Lesions of the temporo-sphenoidal lobe will produce auditory hallucinations if irritative, but as the auditory area on either side is connected with both ears the deafness produced by a destructive lesion will not be noticed. The same is true of smell and taste.



**Fig. 472. Projection Tracts Joining the Cortex with Lower Nerve Centres.**

1. Tract Frontal Lobe to Pons, thence to Cerebellar Hemisphere of Opposite Side.
2. Motor Tract from Central Convolutions to Facial Nucleus in Pons and to Spinal Cord. Its Decussation is Indicated at H.
3. Sensory Tract from Posterior Column of Cord through Posterior Part of Medulla, Pons, Crus and Capsule to Parietal Lobe.
4. Visual Tract from Optic Thalamus to Occipital Lobe.
5. Auditory Tract from the Inter-Geniculate Body to Temporal Lobe.
6. Superior Cerebellar Peduncle.
7. Middle Cerebellar Peduncle.
8. Inferior Cerebellar Peduncle.
- Cn. Caudate Nucleus.
- C2. Corpora Quadragemini.
- V1. Fourth Ventricle.

**CONDUCTING TRACTS.** The centrum ovale, the white substance of the brain, is made up of conducting tracts. Some of these carry motor and sensory impulses from the cortex to the base of the brain and the spinal cord—projection fibres; others again unite the lateral halves of the cerebrum—commissural fibres; while still others join different portions of the cortex with each other—association fibres. Lesions will disturb these different tracts and can be diagnosed only by exclusion.

**PROJECTION TRACTS.** The basal ganglia, the corpora striata, the optic



thalami, and the corpora quadrigemina and geniculata are masses of grey matter the functions of which are not very well understood. Of these the corpora striata are the most important. They consist of two masses of grey matter, the caudate and lenticular nuclei, separated by a band of white matter, the internal capsule. The latter has two limbs, anterior and posterior and contains projection fibres; unless it is involved lesions of the basal ganglia are not recognized. The anterior limb contains fibres from the frontal lobes and its functions and lesions are, there-

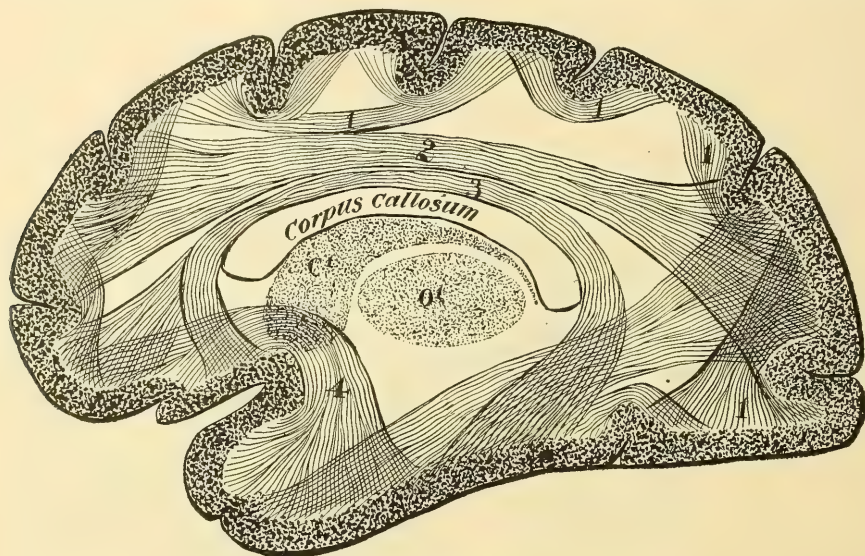


Fig. 473. Association Fibres in Centrum Ovale.

1. Between Adjacent Convolutions.
  2. Between Frontal and Occipital Lobes.
  3. Between Frontal and Temporal Lobes.—The Cingulum.
  4. Between Temporal and Frontal Lobes.
- Ct. Caudate Nucleus.  
Ot. Optic Thalamus.

fore, not understood. The fibres of the posterior limb come from the motor area and occipital lobe. Hence lesions will produce, as might be expected, hemiplegia of the opposite side or paralysis of the lower face, arm or leg, hemianopsia, one-sided sensory disturbances, and speech defects.

The crura cerebri, pons and medulla also contain projection tracts, as well as the nuclei of the cranial nerves. Consequently palsies of these nerves, as well as motor and sometimes sensory disturbances will be produced by their lesions. Thus, paralysis of the third nerve on the side of the lesion with hemiplegia of the other characteristically points to the crus—paralysis of the fifth, sixth and seventh, also with hemiplegia, to a unilateral lesion in the pons.

**CEREBELLUM.** “The cerebellum controls the equilibrium of the body.” Lesions of its middle lobe will cause vertigo and a gait like that of a drunken man, from incoördination.

## CHAPTER V.

### INJURIES OF THE BRAIN AND CRANIAL NERVES.

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**Contusions of the Brain.**—There is a complexus of symptoms, occasionally rapidly ending in death, more frequently followed by recovery, immediate or remote, and at times going on to a picture of compression or inflammation, that has been and unfortunately is still too generally known as concussion of the brain, originally regarded as a purely functional shaking up of the nerve centres. One theory after the other has been advanced until it is now generally acknowledged that so-called concussion means contusion or laceration of the brain. Some have attributed the phenomena to reflex vascular paralysis, others to bone-impact at the point of injury, or at one opposite this, and still others to a wave of cerebro-spinal fluid started by the bending of the bone and acting at a distance, especially in the ventricles. Cases of death from apparently functional concussion have been shown to be due to injuries elsewhere, e. g., spinal hemorrhage, rupture of the heart, etc. As to the lesions, the brain substance is more or less extensively bruised or lacerated; there may be localized or general minute ecchymosis or thrombosis, or hemorrhages into the cortex or from the meningeal vessels. Injury by counter-stroke is very common in contusion. The important point in practice is that such laceration, hemorrhage and hyperemia may lead to fatal brain inflammation, or later on to abscess or to motor, sensory and mental disturbances, and that proper surgical intervention based on localizing symptoms, wounds, or fractures is life-saving when done early, and usually useless when the above phenomena are established.

**SYMPTOMS.** Brain contusion shows itself clinically as shock, the leading features of which are disturbed consciousness and intelligence. In degree the results may be divided into the mild, severe and remote. A patient falls on the head and is stunned, losing consciousness for a short time; there are pallor, weak pulse, superficial breathing, perhaps muscular twitching. As consciousness returns there are vertigo, ringing in the ears, nausea or vomiting and weakness felt on attempting to move the extremities; with this the pulse becomes stronger and more rapid, the face flushes, perhaps, and some mental excitement may follow. The injury and subsequent events are apt to be forgotten. In the more severe form the above symptoms will intensify and persist for hours or days. The patient can be aroused with difficulty or not at all, answers being given in monosyllables. The pupils are contracted, sometimes dilated or uneven, but usually react to light; there may be involuntary defecation and urination, or at times retention. The symptoms of reaction, too, are more marked; the face is flushed, the pulse bounding, headache, photophobia, etc., appear, until inflammation is seen to be present. Of the remote effects, brain abscess is to be thought of and carefully looked for. Epilepsy or even insanity has been noted as a sequela. For weeks or months after such an injury there are mental lassitude, headache and vertigo, or an irritability



which readily leads to bursts of uncontrollable anger and is particularly aggravated by the use of alcohol. A condition somewhat akin to this may develop without previous reaction and has been termed cerebral irritability. Instead of answering in monosyllables when aroused the patient becomes angry and abusive, or surly and refuses to respond; otherwise the symptoms are those above described. Recovery from this condition is apt to be very slow. In consequence of the irritation of the cortex from contusion or laceration, or their consequent hemorrhage, there may be convulsive movements appearing suddenly and involving limited areas, a hand, an arm, the side of the face, etc., or the entire body, either progressively or at once. This will be accompanied or followed by increasing unconsciousness. Coming with reaction or a day or two after an injury such spasm will indicate hyperemia or inflammation with consequent softening, and, still later, brain abscess or a spreading sclerosis. It is generally acknowledged that clean, incised wounds heal kindly and quickly, while lacerated ones do not and cause disagreeable after-effects. Following spasm may come paralysis of the same groups of muscles. The paralysis of contusion is less complete than that of compression and, therefore, its recognition gives greater life-saving possibilities. Deeper lesions are more difficult to localize or recognize, minute lacerations and hemorrhages of the white matter rarely producing definite symptoms. Injuries about or below the floor of the fourth ventricle which are common may cause persistent vomiting, slow pulse and respiration, polyuria or suppression, albuminuria or glycosuria and even hematuria.

**TREATMENT.** The patient should be put to bed with the head low, and kept absolutely quiet. Hot water bottles (well protected, for they produce the most disagreeable burns) are placed along the trunk and lower limbs. Heat to the epigastrium with a sponge or light water-bag is useful. General stimulation or that especially directed to the heart may be called for, care being exercised not to increase thereby the cerebral congestion that accompanies reaction. The treatment, in other words, is that for shock. Reaction should be controlled by elevating the head, covering it with an ice-bag, applying heat to the feet, and, on general principles, by belladonna. Special symptomatic indications will, of course, lead to the administration of other drugs which also have a very useful sphere in incomplete or slow recovery and the remote effects. Exposure to heat, alcohol and any mental exercise or excitement must be proscribed for a long time. So-called brain concussion is particularly dangerous from what is not done, and this is due to the time-honored impression that the condition is purely functional. In every such case, no matter how slight, the scalp must be most carefully examined for wounds and bruises, ecchymoses or hemorrhages from the nose, ear, etc., looked for, and any brain symptoms of a localizing character immediately noted.

The treatment of scalp and skull injuries has already been described. In the presence of localizing symptoms pointing to an accessible and persistent brain lesion the danger of opening an intact scalp, skull and even dura cannot, to-day, compare with that of non-interference. The writer recently operated a case to which he was called with an apology because it was only "concussion," which, however, had not cleared up in three days. After incising a bruise just behind and above the external angular process and trephining a fissured fracture with extensive comminution of



the inner plate a satisfactorily rapid and uninterrupted aseptic recovery followed.

**Wounds of the Brain.**—In this connection it may not be out of place to consider wounds of the brain, already referred to under penetrating and perforating gunshot and other fractures. These may be inflicted by spicules of bone, knives, swords, umbrellas, canes, nails, bullets, etc., entering through fractures of the vault, sides, or back of the head, or through the orbit, nose, mouth or fontanels. Such wounds are particularly dangerous on account of their septic character, encephalitis or abscess resulting early or late, and although remarkable recoveries are recorded they are the greatest of exceptions, as are also those in which foreign bodies have become innocuously encapsulated in the brain. Another great danger lies in the fact that the symptoms are often slight and long delayed, fatal inflammation being sometimes established before their presence is dreamed of. This is particularly the case when the frontal region is injured. More frequently, however, the symptoms of compound lacerations or wounds like those of simple ones come on at once, either general or of a localizing character.

**TREATMENT.** The treatment is that of penetrating fractures: early detection by physical examination or localizing symptoms, the induction of asepsis, drainage and the removal of the vulnerating body, if it be reasonably accessible.

**Compression of the Brain.**—When the firmness and inelasticity of the coverings of the brain are taken into consideration it would appear that but a small encroachment upon its cavity must result in disastrous pressure. There is, beyond doubt, a variation in the contents of the cranium during health, more blood being forced in during inspiration, coughing, sneezing, etc. Again there is an invaluable safety valve in the fact that the cerebro-spinal fluid of the brain can readily pass into the much more elastic spinal canal. As this elasticity varies with the individual, so varies the amount of general pressure necessary to produce appreciable symptoms. Compression may supervene upon contusion or appear independently; it may be general, local, or spreading, and sudden or gradual. Its surgical causes are depressed fractures or foreign bodies, blood extravasations from the intracranial vessels, accumulations of the products of inflammation within the skull, and new growths. It is a question whether bone depression alone can produce compression; certain it is that large areas of the skull may be depressed without producing any symptoms, particularly in the young, but if they are to present they come on at once. Pressure from blood in the substance of the brain or into the ventricles also produces symptoms at once, those of compression being sometimes preceded by convulsions; when the clot is extra- or sub-dural they may not appear for some time and are progressive in character, one centre after another being affected. That from brain or meningeal inflammation will be delayed for several days, while pressure developing weeks or months after an injury is suggestive of abscess. Tumors produce pressure-symptoms very slowly unless of rapid growth. Tumors, abscesses, inflammation and hemorrhage are treated of elsewhere.

**SYMPTOMS.** When compression is general, consciousness is lost either suddenly or after a train of irritative symptoms; pain, vomiting, convulsive movements and signs of increased blood-pressure, such as flushed

face, throbbing carotids, rapid pulse and contracted pupils, are present. When it is well established, there is deep coma, livid face, loss of motion and sensation, stertorous breathing, through flapping of the paralyzed soft palate and cheeks; the pupils are dilated, the one on the side of the lesion more so, usually, than the other, and fixed; the pulse is full and strong, slow at first and rapid later on; the temperature, which may be normal or even sub-normal at first, rapidly rises. All head injuries are accompanied by temperature rise, but the above sequence is especially grave. The skin is usually hot and bathed in perspiration, though occasionally cool and clammy; the bowels and bladder are paralyzed, the urine being retained until overflow appears. When compression is local consciousness may not be lost and the symptoms will depend upon the area affected. Thus, if the motor area of the cortex is encroached upon there may be monoplegia of an arm, a foot, etc., on the opposite side, or a hemiplegia. A spreading paralysis extending from one adjacent motor centre to another is particularly significant of compression. Such a spreading cause is often restricted by the firm falx and tentorium which subdivide the cavity of the cranium. Sensory disturbance is rarely recognized. Large portions of the anterior part of the brain, too, may be compressed without producing symptoms. Compression or laceration of the cranial nerves often gives localizing information.

**TREATMENT.** The treatment of brain compression consists in the removal of the cause, be it bone, foreign body, clot, effusion or tumor. The prognosis depends on whether such treatment can be carried out and that with good surgical judgment, a perfect technique and aseptic wound healing. The different causes receive consideration under their respective heads. Aside from this the treatment is that of any cerebral injury associated with passive hyperemia or inflammation: elevation of the head, the ice-cap, heat to the feet, quiet, catharsis, attention to the bladder to prevent distension, and medication on symptomatic indications, or, possibly, to contract the arteries.

**DIFFERENTIATION.** Head injuries are often mistaken for other conditions in which there is loss of consciousness, such as opium poisoning, uremia, non-traumatic apoplexy and particularly alcoholic intoxication. In every case of impaired or lost consciousness the possibility of a head injury should be first thought of and most carefully excluded, particularly by a physical examination, any contusion or wound being treated as already described. The presence of edema and convulsive movements, the absence of paralysis and stertor, urinalysis and examination of the eye-ground, will help in recognizing uremia. The pin-point pupils before the late dilatation, the absence of paralysis and the odor of laudanum, if that has been used, will do like service in opium poisoning. Non-traumatic apoplexy whether hemorrhagic or embolic is hard to distinguish, especially as it may be associated with an injury. The coma and paralysis are, perhaps, more complete, and if seen early the temperature is said to be sub-normal. The appearance and age of the patient and an examination of the heart and vessels may be of assistance. The treatment, after all, is practically that of a brain injury. Alcoholic intoxication is the condition most frequently causing mistakes. The writer recalls a case sent by a house surgeon to the station house as a "drunk." The man did not "sober up" and finally even the officer in charge recognized the serious-





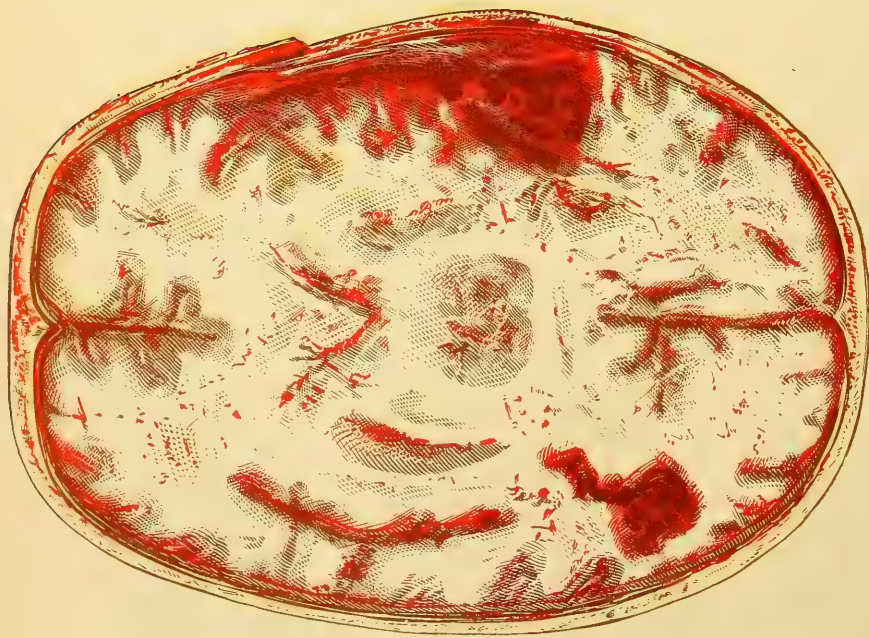


Figure 1. Horizontal section of cranium showing depressed fracture of skull, with extra-dural, sub-dural and interstitial hemorrhage. Number 1, extra-dural clot; 2, laceration of brain substance, with large intra-cerebral clot; 3, same condition from centre coup. Punctate hemorrhages and minute lacerations at numerous points. Characteristic of contusion of brain. Modified after Anger.

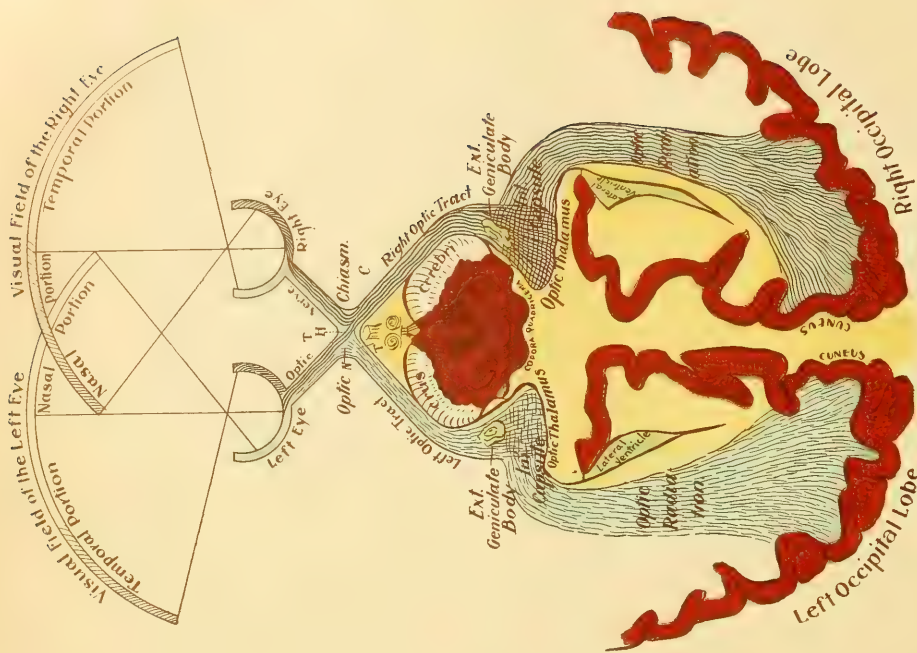


Figure 2. Optic and Visual Tracts.  
N, lesion causing nasal hemianopia; T, lesion causing temporal hemianopia; H, lesion causing bi-temporal hemianopia; C, lesion of optic tract, causing left-lateral hemianopia.

ness of a fully established brain inflammation. There was a small contused wound behind the ear hidden by an abundance of hair and this led to a fissured fracture through which infection had set up a fulminating septic encephalitis. The odor of the breath is of no use, as such cases are usually stimulated and head injuries occur often in the intoxicated. Such patients are more stupid than unconscious, limp but not paralyzed; the pupils are contracted, dilating as they are aroused, and may react to light; the temperature is sub-normal. The author's hospital rule is that a drunken patient who may have fallen should sober up in the accident ward, not in the station house. The cases that are especially dangerous are those of concussion rather than compression, coma usually receiving attention no matter what its suspected cause. A man was recently overcome by the heat and fell wounding his head. He was treated for heat exhaustion by one, then for brain concussion by another. When the picture of brain compression was fully established the surgeon was called in to find a wound, a fracture and intracranial sepsis, as in the case cited above.

**Intracranial Hemorrhage.**—According to its location this may be between the dura and the bone (extra-dural) under the dura into or between the other membranes (sub-dural), or into the brain substance and the ventricles.

Extra-dural hemorrhage is from the middle meningeal artery most frequently, from a sinus, or possibly from the outside through a fracture. Practically, injuries to the middle meningeal artery are the only ones that need consideration. The anterior branch usually suffers in its groove on the inside of the parietal bone. A case has been cited above of injury to the main trunk as it entered the cranium through the foramen spinosum. The posterior branch, too, may be divided in its course over the temporal and parietal bones. A fissure, comminution of the inner plate, or violence by counter-stroke, particularly a blow on the opposite temple or occiput, may rupture the vessel. Occasionally the arteries on both sides of the head are injured, or an extra-dural hemorrhage takes place on one side and a sub-dural one on the other. The superior longitudinal, the lateral and even the cavernous sinus may be ruptured or wounded by fractures, foreign bodies or during operations. (Plate XVI, Fig. 1). The resulting hemorrhage is very severe and may kill by anemia or brain pressure, although occasionally a sinus has been perforated without causing any symptoms. If not fatal, these extra-dural clots may become absorbed, leaving a ring of osteophytes around their site, or they may break down, forming an extra-dural abscess, or be transformed into cysts composed of a sac wall containing a yellowish fluid. Epilepsy or mental disturbance is occasionally associated.

**SYMPTOMS.** Extra-dural hemorrhage produces the most typical picture of compression. The most important symptom is an interval of lucidity after the injury. This may be even as long as ten days. The stunned patient recovers consciousness only to lose it again after a varying interval, according to the rapidity of the bleeding. If concussion is severe this period will be absent. Next to this, hemiplegia of the opposite side is strongly indicative, particularly if of a spreading character. The leg is affected to a much less degree than the arm or speech and not alone as its centre lies nearer the vertex. These symptoms will point to the lesion even though the wound or fracture be on the same side as the paralysis. There will be



a slow, hard pulse, rapid and feeble heart's action coming on later and pointing rather to contusion of or hemorrhage into the brain substance, as does also rigidity of the limbs with convulsive movements. As the clot enlarges unconsciousness and then coma develop. The pupils will also dilate in proportion to the pressure, the one on the side of the hemorrhage being larger and more fixed. Respiration is usually slow and stertorous, while the temperature rises, as in all head injuries.

**TREATMENT.** Operative interference which will remove the clot and arrest the hemorrhage is beyond a doubt the indicated remedy. By it the mortality has been reduced two-thirds at the very lowest estimate. The sooner it is undertaken the better. Localizing symptoms should be the first guide; in their absence contusions, wounds, or fractures of the side of the head. The anterior branch of the middle meningeal artery can be found by trephining an inch and a quarter directly behind the external angular process, this being corroborated by finding the anterior inferior angle of the parietal bone on the skull at the pterion; the posterior branch is reached through an opening on the same level below the parietal eminence. In one instance, failing to find the clot here, an operator opened the opposite side of the head with a like result, but evacuated a mass of blood by incising the dark and pulseless dura. The location of the opening can be varied or it can be enlarged, according to localizing symptoms or the size of the clot. The latter should be carefully wiped or sponged out and the cavity disinfected. If old it will be found tough and adherent. The arrest of bleeding, both from the meningeal vessels and the sinuses, has been described under fractures of the skull. The possibility of air embolism should be born in mind, particularly when the blood-pressure is very low. Ligation of the carotid has been practiced for the control of middle meningeal hemorrhage, with fairly satisfactory results.

**Sub-Dural Hemorrhage.**—This may result from the rupture of the middle cerebral artery, a sinus, or, more often from that of a number of small vessels. While occasionally associated with fracture it is a much more frequent concomitant of brain contusion or laceration. It is the not uncommon apoplexy of the new-born. If the bleeding is from the middle cerebral the symptoms and the cause will closely simulate those of hemorrhage from the middle meningeal, and the opening made for the anterior branch of the latter can be utilized to reach the fissure of Sylvius in which the vessel lies. The author has succeeded in evacuating a large clot and arresting the bleeding in this way. More frequently, however, the blood, coming as it does from small vessels, spreads slowly out into the sub-dural or sub-arachnoid spaces as a thin layer until it covers a hemisphere, sinking between the convolutions and separating their sides or gravitating to the base. Many of these patients die, but if they survive the clot may be very slowly absorbed or organized; it may give rise to meningitis, a spreading sclerosis, or it may break down into an abscess; or, again, it may form one of the afore-mentioned cysts, which are usually honey-combed in character, their meshes containing a clear or yellowish fluid. The symptoms in this form are usually gradual in their onset and slow in their course, and are mostly those of mild cortical pressure, with irritation from brain injuries: restlessness, excitement and spasm; vomiting, sleepiness, and slow pulse; monoplegia or hemiplegia, aphasia, loss





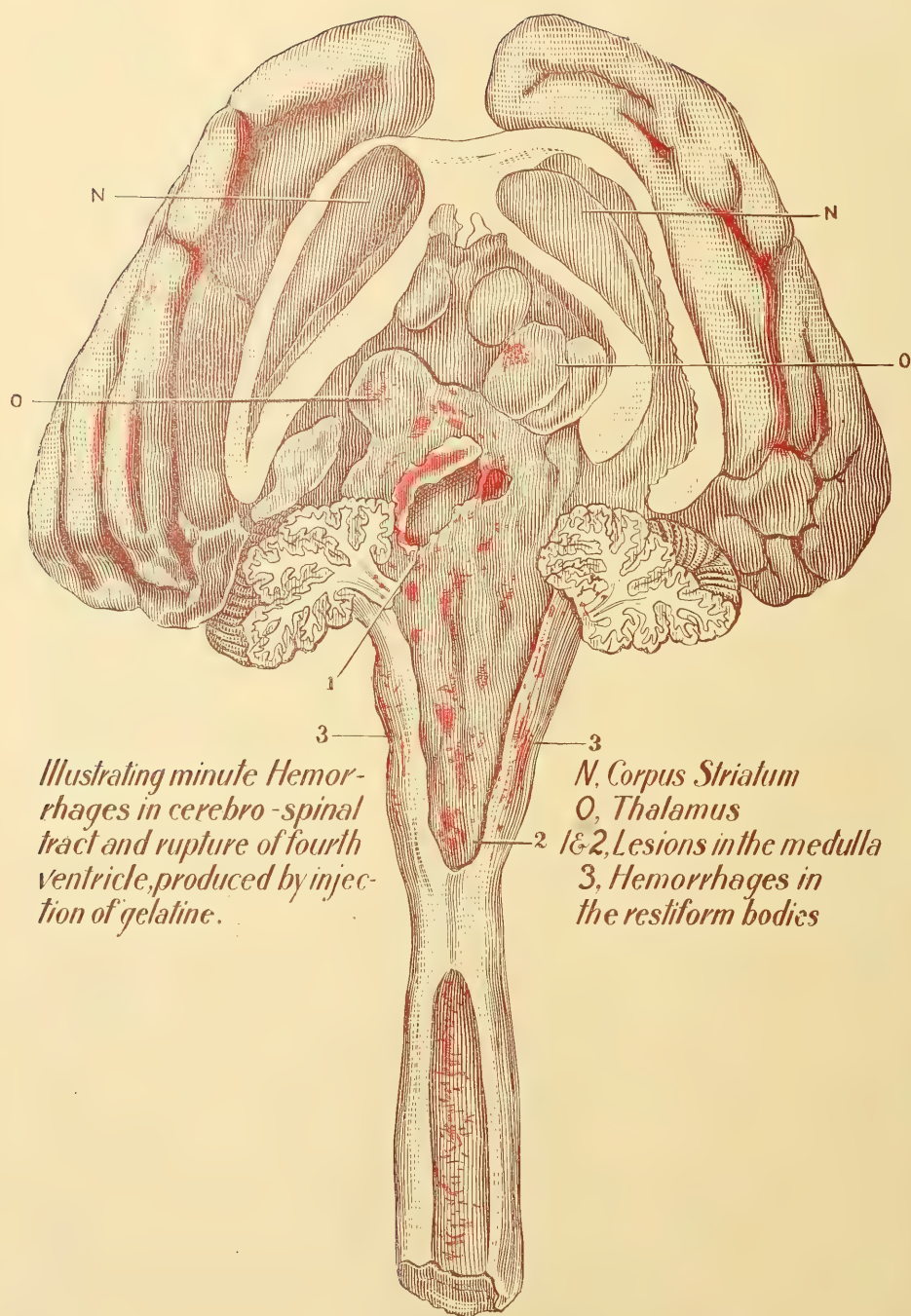


PLATE XVII. --MODIFIED AFTER DURET

of sensation, or hemianopsia, according to the region affected; then stupor, stertorous breathing, rapid irregular pulse, high temperature and uneven pupils. Suppression of urine or polyuria has been observed, as well as albumin and sugar. The remote condition is a deplorable one, headache, loss of memory, epilepsy and even dementia making the patient's future worse than death.

**TREATMENT.** In the absence of surgical indications the treatment is that of head injuries in general, prompt surgical aid being constantly at hand; but in view of the outlook, immediate and remote, any reasonable guide, as a bruise, wound, fracture, or localizing symptoms, should be followed in order to evacuate the clot and relieve the pressure, thus saving life or preventing the after-effects.

**Hemorrhage into Brain Substance or into the Ventricles.**—

This is ordinary apoplexy with a traumatic cause. The deep coma usually obscures all localizing symptoms. If not rapidly fatal such clots have been evacuated, and ligation of the carotid has been suggested to control the hemorrhage in cases of traumatic as well as spontaneous origin. Any head operation in such cases must be largely exploratory and but rarely indicated. The possibility of opening, cleaning out and draining the lateral ventricle is of interest in this connection. It should be remembered however that hemorrhage into or about the fourth ventricle is far more frequent after injury. Clot evacuation from the lateral ventricles has not hitherto been life-saving, although tapping for fluid offers a little more hope. An opening is made an inch and a quarter behind and above the external meatus, and a grooved director or trocar is pushed into the brain toward a point three inches above the opposite meatus. After all, the mere relief of tension by the removal of bone should not be forgotten. It gives decided relief at times. (Plates XVII and XVIII.)

**Injuries of the Cranial Nerves.**—These may be caused by fracture, by blood, or by the consequent inflammation. Their seat may be the deep or superficial origin, or the nerve trunk.

**OLFACTORY NERVES.** The olfactory sense may be lost, increased or perverted—anosmia, hyperosmia or parosmia. The reports of traumatic cases are meagre. Anosmia may be produced by injury to the nerve filaments, the bulb, or the centres.

**OCULAR NERVES.** The optic nerve may be torn or compressed by bone, most frequently at its foramen, either complete blindness or atrophy resulting; or the pressure may be due to blood within the sheath of the nerve, which will often be absorbed. The subsequent optic neuritis will be unilateral unless both nerves are affected, while that of cerebral origin is usually bilateral. When we remember the connection between the nerve sheath and the sub-dural and sub-arachnoid spaces we can readily understand that an increase of intracranial pressure will lead to compression of the nerve and, after a time, to optic neuritis. The latter accompanies many cerebral conditions, notably meningitis, abscess, thrombosis and, especially, brain tumor.

The other ocular nerves may be injured in their nuclei, in their course through the brain and through the cranium, in their foramina of exit, or in the orbit. Irritation may produce spasm of their muscles, but paralysis is much more frequently observed.

Paralysis of the third nerve, the oculo-motor, will affect all the



movements of the eye excepting those of the superior oblique and external rectus muscles. The eyeball will be turned outward and downward; the upper lid droops, the pupil is dilated and fixed and the power of accommodation lost. This condition has been observed after penetrating wounds and severe injuries with persistent symptoms. The coincident hemiplegia when the crus is the seat of the lesion has been referred to.

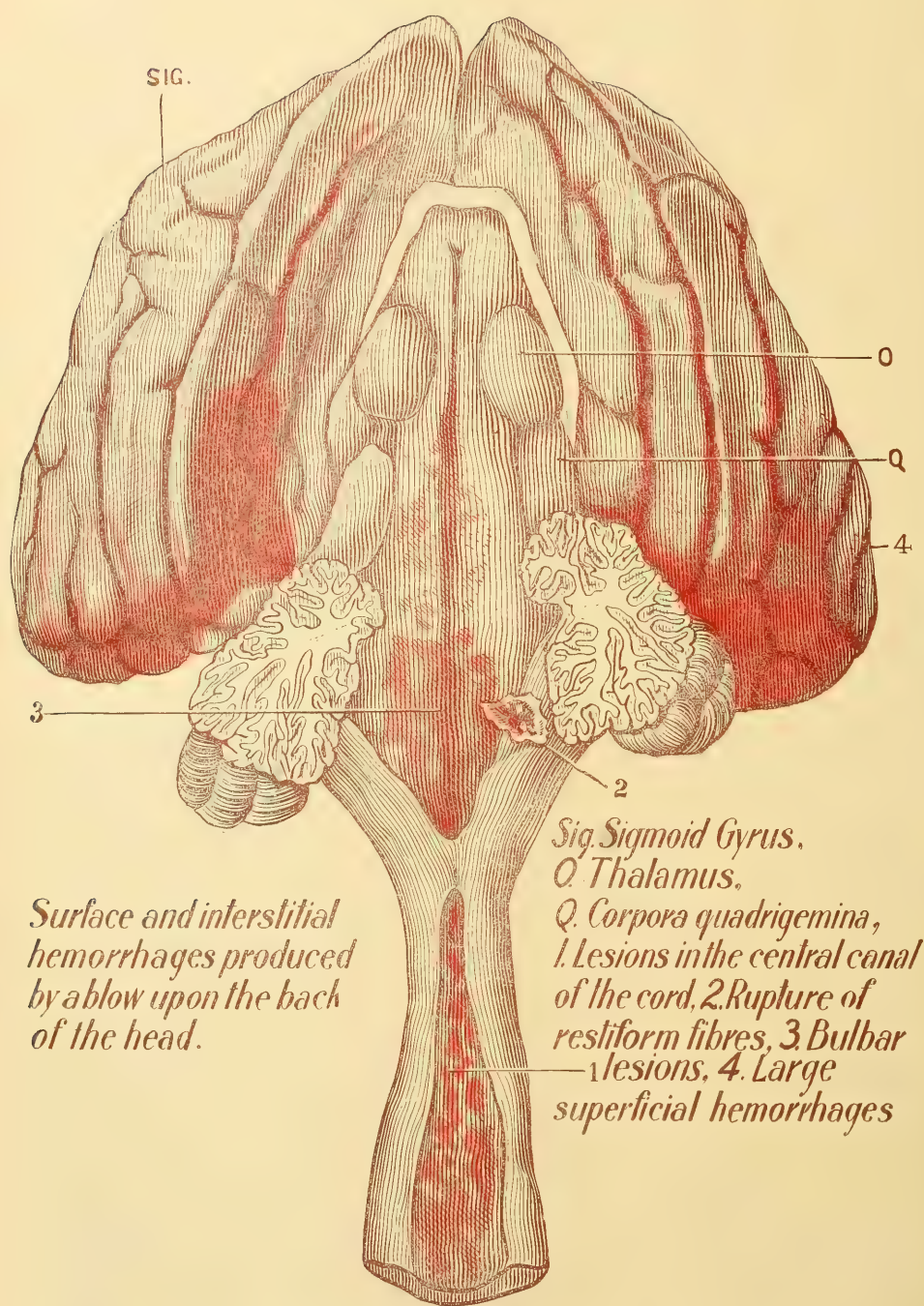
Paralysis of the sixth, or abducens, is not uncommon after fractures of the base. Reference to this, with the associated palsy of the neighboring fifth and seventh nerves and hemiplegia, has been made in speaking of the pons. Rupture of the trunk is rare in spite of its course along the temporal bone. The external rectus being paralyzed, the eyeball will turn inward or converge, producing homonymous as distinguished from the crossed diplopia of divergent squint.

Paralysis, of the fourth, or patheticus, is rare after injuries; there is a loss of movement downward and inward. Vertigo on going down stairs is complained of.

**FIFTH NERVE.** The fifth nerve is often involved with the ocular nerves, as already stated. Traumatic lesions are met with after wounds. In such cases both the motor and sensory functions are affected. After their separation or beyond the ganglion, injuries to the sensory portion are more common than those to the motor. The former occasionally produce neuralgia from irritation, but anesthesia is the usual result. This will coincide with the well-known distribution of the nerve, tender spots being sometimes found, and is characterized by trophic changes resulting in loss of smell, destructive panophthalmitis and unilateral atrophy of the face. The nose, mouth and conjunctiva become dry, the tongue on the affected side is furred, the insensitive cheek is bitten and ulcers are produced. Taste is lost on the affected side throughout the anterior two-thirds of the tongue.

**FACIAL NERVE.** Injuries of the facial nerve may occur at its origin, in the internal meatus or the aqueduct and at or near its foramen of exit. In the first instance the sixth, and perhaps the fifth nerve will suffer, also, and an opposite hemiplegia will be present, as already stated. Taste is not lost. Diplegia has been occasionally observed after central lesions. In the internal meatus there is apt to be an associated lesion of its companion, the auditory nerve. This is said to indicate transverse fracture near the posterior wall of the middle ear. When hearing is not affected a longitudinal fracture may be diagnosed. Suppurative ear disease is a not infrequent cause of the palsy. In the aqueduct involvement of the large petrosal will produce paralysis of the soft palate; that of the chorda tympani loss of taste of the corresponding side of the tongue and dryness of the mouth. When the nerve is torn across the palsy is immediate and permanent; when this is incomplete the cause is probably a clot or a central lesion and improvement may follow. Appearing later, a neuritis should be suspected, and this often produces characteristic localizing symptoms as it spreads. The reaction of degeneration is present, i. e., failing faradic contractility and increasing galvanic irritability. Neuritis soon after an injury should always excite fear of a basilar meningitis. After its exit the nerve has been injured by foreign bodies, the surgeon's knife, the obstetric forceps, etc. The symptoms of a facial palsy are too familiar





*Surface and interstitial hemorrhages produced by a blow upon the back of the head.*

PLATE XVIII.—MODIFIED AFTER DURET.



to require detailed mention, the flabby, expressionless half-face, the drawn drooping mouth, the wide open eye and uprolling ball on attempting to close the lid, etc., being quite characteristic.

**AUDITORY NERVE.** Lesions of the auditory nerve are not well understood. Reference has already been made to the cortical centres. The primary centres are in the posterior quadrigeminal and internal geniculate bodies, and when these are affected hemianesthesia is associated. Traumatisms are more apt to involve the bone, coincident facial palsy pointing to the internal meatus; in deafness from hemorrhage into the labyrinth vertigo is substituted. Blood in the middle ear or wax in the external auditory canal may produce like results.

The remaining cranial nerves are undoubtedly involved at times in traumatisms of the head, but the injury is usually of extreme severity, their symptoms being masked by others. A few cases of isolated lesions have been recorded. Probably the vomiting, the circulatory, respiratory and vaso-motor disturbances often met may be traced to the region in which these nerves originate.

## CHAPTER VI.

### DISEASES OF THE BRAIN.

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#### **Inflammation of the Brain and its Membranes.—VARIETIES.**

From an anatomico-pathological standpoint the classification of inflammation of the intracranial contents is not difficult. A classification based upon the clinical phenomena is well nigh impossible. Thus, there is a meningitis which may be a pachymeningitis or an inflammation of the dura mater, and this again a pachymeningitis externa or endocranitis, the outer surface of the dura serving as an internal periosteum, and a pachymeningitis interna which is similar to that of a serous membrane with associated effusion into the sub-dural space. An inflammation of the sinuses formed by this membrane will be known as a sinus phlebitis, often resulting in a sinus thrombosis. Inflammations of the arachnoid and pia, on the other hand, are classed together as a leptomeningitis, although some add the term arachnitis. The effusion takes place into the meshes of the pia and into the sub-arachnoid space. Ventricular effusion may be associated with this as well as with inflammation of the brain substance adjacent to them. Cerebritis means an inflammation of the brain itself and cerebellitis of the little brain. The encephalon consists of the cerebrum, cerebellum, pons and medulla. The term encephalitis, then, would apply to an inflammation of all these structures. In point of fact, however, an inflammation beginning either in the meninges or in the encephalon is apt, sooner or later, to involve the other, so that it is better to understand by encephalitis a more or less general inflammation of the encephalon and its membranes. It is readily appreciated, when we recall their intimate connections, that the cord and its coverings must often become implicated by such an encephalitis. Again, such inflammation may be diffuse or circumscribed, proliferating or destructive, acute or chronic.

*Diffuse Form.* In the diffuse form the process will spread over large areas of the structure first involved, with a rapidity corresponding to the intensity or extent of the cause. Adjacent structures, too, will be implicated until a general encephalitis is present. In the circumscribed variety the inflammation will be limited, although perhaps involving more than one structure.

*Proliferating Form.* A proliferating inflammation will show itself by diffuse or circumscribed thickenings and adhesions of the membranes to each other and to adjacent structures, and more or less extensive sclerotic changes in the encephalon.

*Destructive Form.* By a destructive inflammation is meant one in which the inflammatory products or the tissues break down into pus. The result will be either a spreading suppurative serous inflammation, or a phlegmonous one in the meshes of the pia. Occasionally the spread may be slow enough to allow adhesions to form, and in consequence encysted pus accumulations will be found in or under the different membranes. In the substance of the encephalon such a process usually shows

itself as an abscess, either rapidly spreading and surrounded by a zone of inflammatory softening or encapsulated by one of proliferating inflammation.

*Acute and Chronic Varieties.* The terms acute and chronic explain themselves. The latter is naturally more apt to be circumscribed, but, as already stated, may serve as a focus or irritant for a spreading or proliferative inflammation, in this way becoming diffuse. Chronic abscess, or one appearing after months or years, has also been mentioned. The acute variety, on the other hand, is more apt to be diffuse. In the membranes, whether suppurative (which is the common form) or not, it will resemble that of similar tissues elsewhere. Simple acute inflammation of the brain manifests itself by edema and swelling, and multiple minute and punctate redness on the cut surface. The affected portion becomes so soft that it can be washed away by a gentle stream of water. This condition is termed red softening. The vessels of the pia will also be engorged, and there will be an accumulation of turbid serum in the sub-arachnoid and ventricular spaces.

**CAUSES.** Inflammation of the brain may be due to a great variety of causes, such as syphilis, tubercle, tumor, cysts, caries and necrosis of the skull, diseases of the blood vessels, alcohol, etc. Far more frequent, however, are traumatisms, such as contusions, lacerations, intracranial hemorrhage, injuries to nerves, fractures, etc. The relation of these causes to preventive surgery has already been emphasized. Of still greater importance are the septic infections, and they merit a more detailed consideration. These may take place in a number of ways. A common example is a compound fracture with wound infection. Another is a penetrating fracture which as already said is particularly dangerous and treacherous. Foreign bodies act in a similar manner. Again, when we remember the membranous prolongations that accompany the different nerves through their foramina of exit it will be seen that an infection on the outside has an easy path of entrance. This is especially true of the nose, the orbit and, above all, of the ear, which is the most common source. Aside from the nerve sheaths the vascular channels frequently serve to carry the infection, this being particularly true of the cavities above mentioned. Thus a thrombosis on the outside in connection with a cellulitis, or one of the diploic veins from a septic inflammation of the skull, can easily spread by continuity or by reversal of the stream to the intracranial venous channels. To this should be added the path by continuity along the perivascular sheaths, as well as emboli, either from neighboring structures, as the ear, or from a distance, as the lung. Again, the infection may spread by contiguity of structures, as from the bone to an adjoining sinus or from the bone to the membranes, one after the other, until the brain is reached. The process will be limited or diffuse according to the presence or absence of adhesions closing the spaces between the membranes.

**SYMPTOMS.** The symptoms of an acute encephalitis may be divided into the systemic, those referable to the head, and, occasionally, the localizing. They will appear usually on the second day after an injury. There is a rapidly rising temperature, sometimes to a remarkable height, quick, full and bounding pulse, and hurried respiration. To these are usually added constipation, anorexia and coated tongue. There will also



be severe headache, with tenderness and local temperature rise of the region injured. Vomiting is not uncommon. Hyperesthesia is quite constant, showing itself by general sensitiveness of the skin, photophobia with contracted pupils, and dread of noise, jars, etc. At first the patient will be very restless and unable to sleep, then delirious and, at times, hard to restrain. Unconsciousness, stupor, dilated pupils, paralyzed sphincters, stertorous breathing and coma close the scene. In favorable cases the last named symptoms will not appear and the previous ones will gradually subside, slow recovery following, very much as after severe contusions. The cerebral irritability noted in that connection not infrequently follows. Localizing symptoms are uncommon in an acute encephalitis of any extent being more frequently produced by the injury. Weakness or spasm of the muscles of one side, or symptoms pointing to the different cranial nerves, if the inflammation is at the base, are usually all that will be found.

*Mental State.* The irritability above referred to is the chief characteristic of chronic encephalitis, and is subject to the greatest variations. It may follow the subsidence of an acute attack, or a contusion or any injury of the head. Other symptoms are rise of surface temperature over the injured point and headache, either general or limited to the this region and aggravated by alcohol and mental exertion or excitement. Such patients are sleepless, cannot remember well and are subject to cerebral vomiting, vertigo and bursts of uncontrollable anger. The last named was the only symptom remaining after recovery from a very extensive compound fracture of the frontal bone, treated by the author, which was followed by encephalitis. Aside from these there may be disturbances of motion, sensation and special sense; traumatic epilepsy or localized paralysis, anesthesia or hyperesthesia, optic neuritis and abnormalities in function of the different cranial nerves. These symptoms may slowly improve or disappear on the removal of the cause, if this is not done too late. Occasionally they will continue to grow worse until death, which is preceded by the picture terminating acute inflammation. Abscess is not an uncommon sequel. The symptoms, described elsewhere, come on late, months or years after an injury, and may be preceded by apparent recovery or symptoms of chronic inflammation.

*TREATMENT.* The general and surgical treatment of acute encephalitis has been given under injuries of the head. The remedies that would most naturally suggest themselves are aconite, veratrum viride, belladonna, gelsemium, stramonium, hyoscyamus, arnica, cuprum, etc. As elsewhere, they must be individualized. When stupor and its concomitants appear there is but little hope even from surgical intervention. The surgical treatment of chronic encephalitis belongs to contusion, compression, hemorrhage, tumor, etc., and has received separate consideration according to the cause. In the absence of localizing symptoms, rest in the fullest sense of the word, medication carefully selected according to symptomatic indications, with careful attention to habits, surroundings, diet, companions, etc., will often accomplish a great deal. The insidious and late development of abscesses should always be watched for, as well as the slightest sign, subjective or objective, that may point to the location of the irritant or lesion. Before leaving this subject, reference should be made to the palliative if not curative results from the relief of tension. Only quite recently the author saw a remarkable recovery follow

the trephining of a fissure and evacuation of an enormous quantity of subdural serum. At least another chance is given by draining off this inflammatory effusion and pressure is relieved by removing bone. Should such a trephine-opening show a purulent meningitis, a second opening at a distance and through-and-through irrigation has, at times, proved beneficial. This is but the application of good surgical principles, such as are used elsewhere, to the contents of this unyielding bony box.

**Abscess of the Brain.**—CAUSES. The causes of brain abscess are traumatisms, with or without fracture of the skull, and suppurative processes in the ear, nose and orbit. Probably one-half, at least, are due to ear diseases, particularly otitis media. Occasionally they are the result of metastases from the heart, lung and intestine, or they appear during the course of pyemia or general tuberculosis. Multiple abscesses are met with in connection with the last two diseases but, as a rule, brain abscess is single. In tuberculosis the infection is, in all probability, a mixed one. Bartlett has reported a case operated by the author which belongs to this class. Almost the entire right hemisphere was involved, eight ounces or more of pus being evacuated. The quantity is usually much smaller.

**TRAUMATIC ABSCESSSES.** These may be acute or chronic. The former will appear in about two weeks after an injury, usually a compound fracture which has been followed by wound infection. The fact has already been emphasized that punctured fractures, whether penetrating or not, are especially prone to septic complications. Acute encephalitis is more likely to follow extensive wounds and fractures. Such abscesses are usually cortical, or between the dura and brain, adhesions preventing a diffuse meningitis. Their most frequent location is in the frontal or parietal lobes; exceptionally they have been met with in the basal ganglia, pons and medulla. An acute abscess consists of a collection of pus, often greenish in color and of an offensive odor, mixed with sloughs and clots and without any limiting wall, but surrounded by an area of red softening. Erosion of a vessel may cause an apoplexy into the abscess cavity. Its progress is rapid and soon fatal unless the pus is evacuated. Such evacuation has, in rare instances, taken place spontaneously through a fracture and wound.

Chronic abscess runs a different course. The injury is often a slight one, the result most frequently being cerebral contusion. It is claimed that a lesion, of the bone, or at least a break in the continuity of the scalp, must have existed. However this may be, there is not uncommonly the

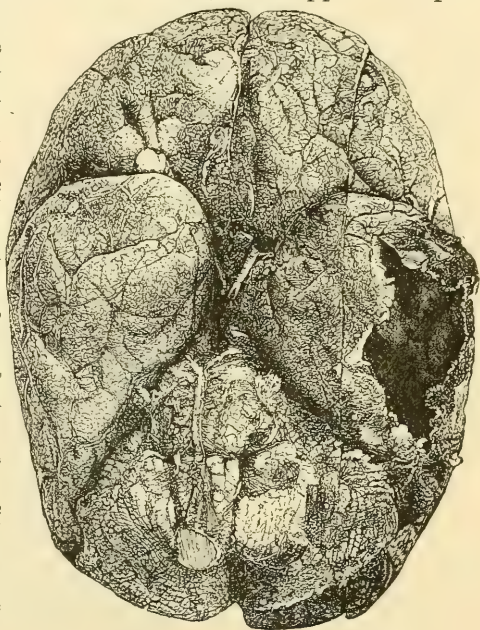


Fig. 474.  
Necrosis of Brain Following Abscess.



history of prolonged wound suppuration. Symptoms of intracranial inflammation, even those of acute abscess ensue and become chronic or disappear, or there may be only the transient ones of a slight contusion. Weeks, more frequently months, and even years (in one instance twenty-eight years) may elapse before the signs of abscess appear. Again, such an abscess may be carried about for a long time without giving signs of its existence, this being especially the case when it is located, as usually happens, in one of the "dark areas" of the brain; it may be found post-mortem, or of a sudden be awakened into activity, spreading rapidly or bursting into the ventricles, the sub-arachnoid, or sub-dural spaces. A chronic brain abscess consists of a collection of pus lying in the white substance surrounded by a zone or capsule of proliferating inflammation. This capsule has been aptly termed the pyophylactic, instead of the incorrect "pyogenic membrane" of old.

**ABSCESSSES OF OTITIC ORIGIN.** Abscesses of otitic origin will also present the characteristics of the acute and chronic forms just described. They are always found in the temporo-sphenoidal lobe, directly over or above and behind the anterior surface of the petrous bone, and in the anterior portion of the lateral lobes of the cerebellum adjoining the posterior

Mastoid Antrum.



Ridge of Fallopian canal.

Middle ear.

**Fig. 475. Section of Left Temporal Bone Showing Communication Between Mastoid Antrum and Middle Ear.**

aspect of the temporal bone and the sigmoid sinus. The middle lobe is rarely implicated. These abscesses are more frequent, too, on the right side, because the sinus on this side is larger and closer to the cavities in the temporal bone through its encroachment upon their walls. Cerebral abscess is four times as frequent as cerebellar.

Besides these, ear diseases may give rise to meningitis, sinus thrombosis and extra-dural abscess, the last named being quite possible, also, as a sequel to inflammations of the cranial bones from other causes. These different processes are readily understood when we consider the relations of the temporal bone and the thin osseous barrier that separates its cavities from the middle fossa, membranes and temporo-sphenoidal lobe above, and the membranes, sigmoid sinus and cerebellum behind. Naturally, therefore, disease of the tympanum is more likely to be followed by temporo-sphenoidal abscess, while involvement of the mastoid most often leads to sinus and cerebellar infection. In a caries of the tympanum if perforation of the roof takes place the dura will throw out protective granulations which may sprout into the middle ear through the bony opening. Here they have been mistaken for polyps, and their extraction has removed the



protective barrier they formed and thereby spread the infection. The same may occur in the mastoid cells. Another result of such perforation is extra-dural abscess, which may be localized or diffuse itself over a large area. Occasionally the pus will find an outlet through this perforation into the ear or mastoid and thus escape. It has been suggested that the amount of discharge may be of diagnostic value in this connection, a larger quantity than would probably come from the ear indicating an internal pus cavity. Dural inflammation sooner or later involves the underlying membranes and then the cortex; suppurativemenigitis or sub-pial and cortical abscess follow, according to the absence or presence of limiting adhesions. Extension of the process to the white substance of the brain can of course take place, but more frequently a considerable amount of comparatively normal cortex overlies a sub-cortical abscess. Such infection, in all probability, travels along the perivascular sheaths into the interior of the brain. It may also extend by means of a spreading thrombus, or be carried from this by the reversed blood current, the veins being without valves. Involvement of the sigmoid groove will produce similar results—pachymeningitis externa and perhaps extra-dural abscess, sinus phlebitis, leptomeningitis, and cerebellar abscess by contiguity, or sinus thrombosis—and spread to the cerebellum by the vascular channels.

The results of disease in the nose and orbit are much the same. The frontal and ethmoidal sinuses present conditions eminently favorable for the unmolested growth of micro-organisms, not unlike a clogged middle ear and the mastoid cells, while the prolongations of the sub-dural and sub-arachnoid spaces around the optic nerve easily become implicated in suppurative processes of the orbit and globe. Such infections are not infrequently the sequelæ of operations in these cavities.

In the young, when the component parts of the temporal bone are not yet united, infections can spread with greater ease. Tubercular disease may cause slow but extensive destruction of the interior of the petrous portion, ending in a meningitis. The aqueduct of Falopius, too, is easily infected, resulting facial paralysis being more common in children. The facial and the auditory nerve sheaths may also serve as channels leading to the ganglia at the base of the brain and to the cerebellum. It is said that involvement of the auditory nerve, as shown by the absence of bone conduction, is presumptive evidence of cerebellar mischief. So, too, facial paralysis of the peripheral type points to advanced bone destruction. Again, as middle ear disease involves the intracranial contents, it may in like manner spread outward, attacking the bone overlying the mastoid cells and producing periostitis with pus accumulations under this membrane, or burrowing downward and inward to form a variety of retro-pharyngeal abscess, or forward to appear deep in the cervical region.

The ear inflammations which most commonly produce intracranial complications are not the acute, but the chronic. The discharge too is not necessarily fetid, but rather scanty and apt to be inspissated. Such accumulations team with pathogenic organisms. The mucous membrane is destroyed, the bone diseased, and while more room is given by these conditions as well as by the rarefied mastoid cells, the imperfect drainage through the drum-head, the clogging by inspissated pus and the filling up of the tympanic cavity and its adnexia with granulation tissue, all combine to form an ideal incubating chamber.

Sinus thrombosis is most frequently infective and then always secondary to external lesions, such as compound fractures, cellulitis, periostitis, abscess, etc. The most frequent cause is middle ear disease and the sinus affected is the sigmoid. As a result of the associated phlebitis the clot becomes firmly adherent to the walls and occludes the lumen completely, preventing hemorrhage; it may then spread to other sinuses or down into the internal jugular vein. Disintegration of the thrombus soon takes place, pus forming, which, with swarms of bacteria, may be carried to other parts by the circulation. Infection also spreads to adjoining tissues through the sinus walls. Sometimes organization of the terminal portions of the clot may result in protective occlusion.

**SYMPTOMS.** *Acute Variety.* Abscess of otitic origin, situated as it usually is, in the temporo-sphenoidal and in the lateral lobes of the cerebellum, rarely produces local symptoms. Traumatic abscess, on the other hand, while it may be difficult to locate when in the frontal lobes, is more apt to indicate its position in the parietal. The history too is of value. In the first instance there will be a chronic, sometimes an acute, ear discharge with sudden cessation, frequently from exposure to cold or local treatment, and the development of severe pain about the ear or side

of the head, followed by serious brain symptoms.

In the traumatic variety these will appear after an injury, recent or remote, the marks of which are often of diagnostic value, although they should always give way to localizing symptoms. Acute abscess is ushered in by a rigor and usually a temperature rise. Then develop such brain symptoms as headache, delirium and projectile vomiting, followed by slow pulse and respira-

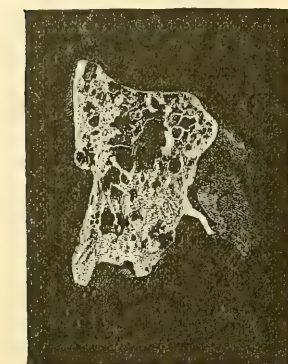


Fig. 476.

Section of Left Temporal Bone Showing Mastoid Antrum and Cells.—Macewen.



Fig. 477.

Section of Left Temporal Bone Showing Mastoid Antrum and Cells.—Macewen.

tion, convulsions, paralysis, coma and death. The temperature may not rise or may quickly fall to normal or subnormal, but the local temperature over the seat of abscess is usually elevated. Urinary chlorides are said to be diminished, while the phosphates are increased. Local tenderness to percussion points to superficial abscess. Optic neuritis is occasionally noted.

*Chronic Variety.* Chronic abscess pursues a more insidious course, this being one of the strongest characteristics distinguishing it from meningitis, thrombosis and even tumor. Chill is usually present and may be slight or severe, sometimes being taken for a convulsion; when repeated, systemic infection is to be suspected. The temperature may be normal or subnormal but is usually about 94 degrees; here, too, there is a local temperature rise. The pulse is slow and at times intermittent; slow pulse rather points to the involvement of the cerebellum. Respiration is retarded as well and may be of the Cheyne-Stokes type. Vomiting is



present early and is unaccompanied by nausea, being often brought on by sitting up; when persistent it also indicates cerebellar trouble. Headache is quite constant and may be general or worse on the affected side; it is subject to exacerbations, often increasing as the temperature rises and the pulse drops. While sometimes of localizing value it is more often misleading; even in cerebellar abscess it may be referred to the forehead. It is claimed that the headache of abscess from ear disease is particularly severe. Vomiting and persistent headache should always arouse a suspicion of intracranial trouble. The patient is irritable or dull, slow to answer questions, often using monosyllables, cannot think or remember, and is inattentive except for brief periods. At times delirium is present. Convulsions, though often met with, are not usually localizing; paralysis is more frequently indicative. The appearance of prostration and illness is out of proportion to the other symptoms and this is progressive. The tongue is coated, the breath peculiarly offensive and the bowels constipated. Then come drowsiness, unconsciousness and coma. These symptoms are subject to marked changes, particularly to deceptive ameliorations. Optic neuritis is uncommon with the chronic abscess; the pupil, however, is usually more dilated and sluggish on the side of the lesion. If this be small it may be contracted and sluggish. Rupture of an abscess on the surface or into the ventricles is rapidly fatal. The symptoms are often fulminating; vomiting, spasms, collapse, high temperature, hurried respiration, coma and death follow in short order.

Symptoms due to the location of the abscess are of but little value, probably because such pus accumulations are soft and make equable pressure, and because they are located mostly in the dark areas or in the white substance of the brain. Thus temporo-sphenoidal abscess will not give rise to local signs unless the first and perhaps second convolution are invaded, when sensory aphasia develops. When in the lateral cerebellar lobes it cannot be recognized, staggering showing itself only after the middle lobe or the peduncle at the base is involved. Abscess of the frontal lobe must involve the third convolution before any but the general mental derangements already referred to develop. Those in the parietal lobe will more frequently be associated with motor and sensory disturbance, convulsive or paralytic, adjoining centres being necessarily affected with their spread. When the anatomical order is reversed and lost sensation is marked, involvement of the internal capsule may be suspected.

After evacuation the healing process often anchors the brain to the membranes and skull in such a manner as to produce shocks from sudden jars or movements. Temporary unconsciousness may result, and the symptom is often an annoying one.

It is important to distinguish brain abscess from the conditions already referred to as having the same causative origin and often associated with it, the relative frequency of abscess, meningitis and sinus thrombosis being about the same.

In mastoid disease there are, beside an otitis media, localized swelling, edema and redness, at times extending into the neck. The process is generally tender, particularly along its posterior border, and may even feel larger than its fellow. Head symptoms may be associated, without intra-



cranial complications, and will clear up after the appropriate operation. Any or all of the intracranial infections may coexist.

**MENINGITIS.** Meningitis, particularly a suppurative leptomeningitis, has been shown to exist independently of brain abscess and to result from its rupture or to lead to it. The difficulty in differentiating inflammation of the brain from that of its membrane has also been spoken of. The distinctive features of a meningitis as compared with the processes under consideration are its sudden onset and progress, the rapidity of the pulse which is also weak and intermittent and marks by its frequency the extent of the process, and the high temperature, which is not subject to variations. There is cerebral irritation, instead of compression which, however, may come late; this is shown by hyperesthesia, general and of special sense, strabismus, muscular twitchings, delirium, spasm, the head often being retracted and the neck rigid. To this is sometimes added erratic involvement of the different cranial nerves.

Extra-dural abscess, which is a localized, suppurative pachymeningitis externa, has been shown to implicate the underlying membranes to a greater or less extent. It also presents a high temperature, localized pain and tenderness on percussion, with edema of the scalp and the history already described.

**INFECTIVE THROMBOSIS.** This is characterized by repeated rigors, a high temperature which is subject to marked fluctuations, and a very rapid, weak pulse. It is said that this pulse of thrombosis and meningitis is not slowed by narcotics and chloroform. The region of the sinus is tender and painful on percussion and the jugular vein can be felt like a hard cord in the neck. In consequence the veins of the face are apt to be distended. There may be slight exophthalmus, and choked disc is not uncommon. Tenderness in the apex of the cervical triangles, anterior and posterior, and rigidity of the sterno-mastoid have also been noted. The mind is usually clear. Sweating, prostration and diarrhea soon follow, until the "typhoid state" is established. Then come the symptoms of a general pyemia with joint suppurations and infarcts in the lungs and liver. Mastoid disease will precede this condition.

**TREATMENT.** The result of abscess being death, evacuation offers the only hope. In the absence of localizing symptoms purely exploratory operations are justifiable. Even apparently hopeless cases have occasionally been saved. A case in point is one recently operated by the author. An acute otitis media had run along an uneventful course for several weeks. The discharge became bloody and then ceased, the man becoming suddenly stupid. The mastoid which was swollen, red and tender was opened and cleaned out, as well as the middle ear. No relief was given and six hours later he was profoundly comatose, sweating profusely, completely paralyzed and the lungs were rapidly filling. In fact, he appeared to be dying. Operation was done without an anesthetic and over four ounces of pus evacuated from the right temporo-sphenoidal lobe. The next day he was cursing his attendants and on the following was himself again. Uninterrupted recovery followed. The lesson was an impressive one to all interested.

As already stated, the causative history, wounds, scars, fractures, sinuses, etc., will often indicate where the skull should be opened. Localizing symptoms, when present, are of still greater value. A second or

more openings if the first does not disclose the abscess, are not only justifiable but advisable in view of the inevitable result that follows if the pus is not evacuated. Such openings may also be needed to obtain dependent drainage. The operation is that of trephining and has been described. The dura will bulge, will not pulsate and may be discolored, the opening into it sometimes evacuating the pus at once. If the latter be deep-seated the brain will also protrude, pulsation being absent. A grooved director should be gently pushed into the substance of the brain in the probable direction of the abscess, be carefully withdrawn in the same line and introduced again and again if necessary. The thick pus, which cannot be drawn through a hypodermatic needle, will ooze out along the groove of the director. The point of this should be sharper than the one

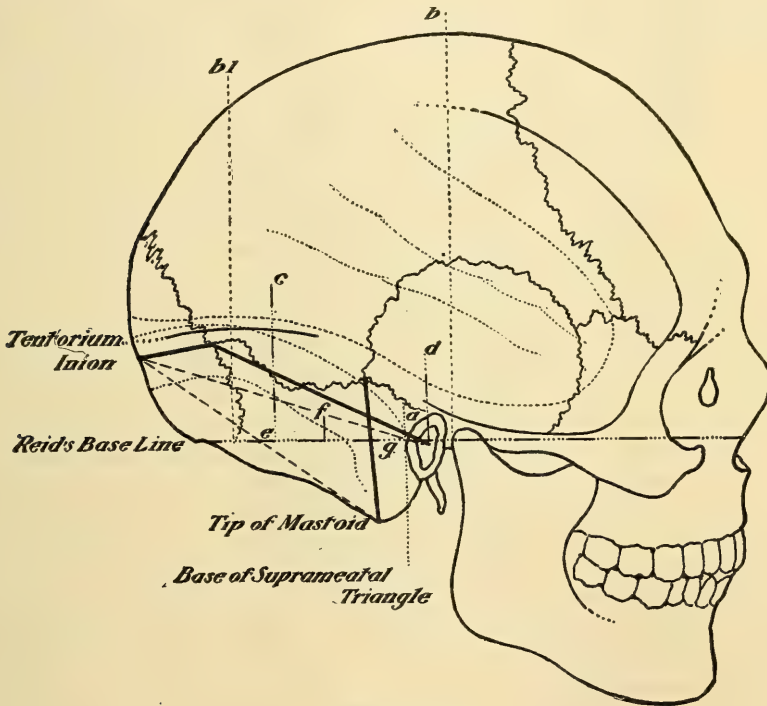


Fig. 478.

## Landmarks on Skull for Abscess Operation.

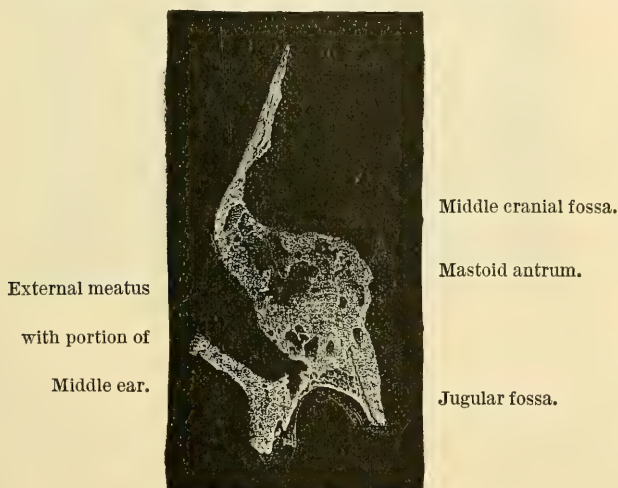
ordinarily sold, as it not unfrequently happens that the tough abscess wall is pushed on ahead of the instrument and not perforated. Once pus is found the opening is enlarged with a knife guided by the director, cutting from before backward or vice versa. The cavity is cleaned with peroxide of hydrogen, gently curetted and irrigated with boiled water or a mild antiseptic. Drainage is provided for in a dependent direction, with a tube or a strip of gauze and the wound packed. The brain fills up the cavity and, if deemed safe, secondary suture of the dura can be practiced, gold foil being used to prevent adhesion. More frequently, however, partial or late plastic closure with drainage during the usually slow healing process is preferable.

Abscess of otitic origin often requires preliminary operation on the ear or mastoid. Thus, in any case of middle-ear disease in which cerebral symptoms appear the drum-head should first be opened, both above (pus usually lodging in the attic) and below, for drainage. More frequently, however, this membrane is more or less completely destroyed and a thorough cleansing and disinfection of the middle ear immediately precedes the operation. Signs of external inflammation over the mastoid call for incision through its periosteum and inspection of the bone. In the presence of brain symptoms, presumably due to otitis media, the interior of the mastoid should be exposed and the cells, antrum and middle ear cleaned out. The ear is held forward, the posterior root of the zygoma and the mastoid tip located, and an incision made between these points a quarter of an inch behind the posterior border of the osseous meatus. The bone is at once exposed, as well as the posterior wall of the external auditory canal. Recognizing the supra-meatal triangle (Fig. 478, a), an opening is made within it, beginning at its base and working inward and forward until the antrum is reached. A small gouge and mallet, a quarter-inch trephine, or a burr worked by the hand or a dental engine will answer for the purpose. The depth of the antrum increases in the same ratio as that of the membrana tympani. By working downward and backward from the antrum the interior of the mastoid cells will be exposed, while by keeping close to the roof of the auditory canal the middle ear is reached and can be cleaned out. The stapes should be left if possible, to save some hearing. Care should be taken to avoid injuring the facial nerve, its canal running in the lower, posterior and then inner portion of the antrum, the anterior external and superior portion of which is therefore safe. The anesthetist should be instructed to carefully watch for facial twitchings, to prevent destruction of the nerve. Granulations in this region too should be touched before removal to see if the face twitches. The chorda tympani is usually torn in removing the malleus and incus. Such granulations in the mastoid or middle ear should be examined to see if they originate within the cranium. They will lead respectively to the lateral sinus and posterior fossa, and upward into the middle fossa. The opening, in the former instance, should be enlarged, the inner wall of the mastoid carefully removed, if diseased, and thorough disinfection and drainage obtained, further steps being taken as indicated. When they extend upward to the middle fossa, access and drainage are unsatisfactory and often impossible; hence the skull should be opened above the ear and the infected area cleaned out, the perforation enlarged and proper drainage instituted, further lesions receiving their appropriate treatment.

Temporo-sphenoidal abscesses are usually between two vertical lines drawn upward from "Reid's base line", one from the depression in front of the base of the tragus, the other from the posterior border of the mastoid. (Fig. 478, b and b'). These lines are also used to indicate the extremities of the fissure of Rolando. Most of them are located in what is known as the "dangerous region," that is, a circle a little over an inch in diameter, the centre of which is an inch and a quarter behind (on Reid's base line) and an inch and a quarter above the external auditory meatus. (Fig. 478, c). It is thought safer to go an inch and three-quarters above the meatus in order to make sure of avoiding the upward curve of the lateral sinus. Another point for trephining is a short inch directly



above the external auditory meatus (Fig. 478, d), the anterior surface of the petrous being accessible through this opening. Cerebellar abscess is best reached by trephining below a line drawn from the external auditory meatus to theinion, midway between the latter point and the tip of the mastoid (Fig. 478, e), or about two inches behind the meatus and an inch below this line. The opening will be just back of the masto-occipital suture. The bone here is very thin and the sinus well out of the way. Some advise that the sigmoid groove be exposed first, as the infection usually spreads to the cerebellum from there. The opening can then be enlarged downward and backward. The treatment of the abscess is the same as in the brain. Care must be taken not to injure the superior vermiform process in the exploration which should be made inward, forward and slightly upward to reach an abscess in the usual location and to avoid the sinus. For the latter reason the dural flap should have its base upward. Respiratory difficulty has been observed and calls for change of position, rapid completion of the operation and artificial respiration, the

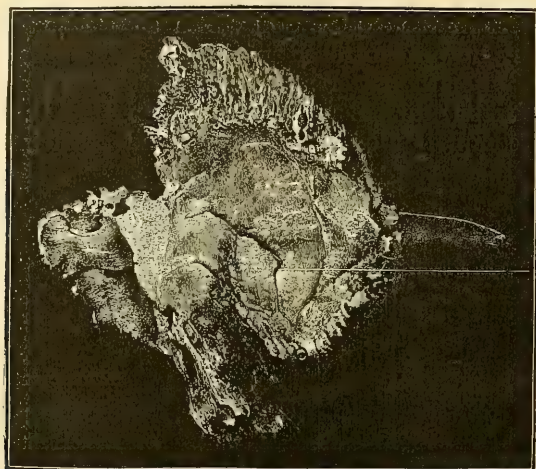


**Fig. 479. Section of Right Temporal Bone Showing Relations of Mastoid Antrum.**

Coronal section through the temporal bone, showing the mastoid antrum in its relations to the middle cranial fossa, the external auditory meatus, and a small portion of the middle ear toward its posterior aspect.—Macewen.

latter having been kept up, in one instance, for twenty-four hours. The course of the lateral and sigmoid sinus has been described under cerebral topography. To reach the sigmoid sinus an opening is made an inch behind the meatus and a quarter of an inch above Reid's base line. (Fig. 478, f). As already stated, this can be enlarged in order to explore the cerebellum. It can also be explored lower down, this being convenient after working on the mastoid. This portion of its course corresponds to a line drawn from the mastoid tip to the parieto-squamo-mastoid junction or to the posterior root of the zygoma. This junction also marks the union of the superior petrosal and sigmoid sinuses. The knee of the latter is just back of the meatus. The trephine should be applied on a level with the meatus and three-quarters of an inch behind it, with its centre in front of the above mentioned line. (Fig. 478, g). Diseased bone between the sinus and antrum or mastoid cells should be removed, granulations

and pus in the groove carefully scooped out, a path of infection to the cerebellum being looked for, and the sinus examined for clot. If in doubt, a small opening is made into it which can be readily closed if blood escapes. In the absence of hemorrhage the sinus should be freely opened and cleaned out until bleeding is free. The control of the latter has been described under fractures. Air embolism has also been mentioned and is a possibility here. If the internal jugular is involved, the attempt should be made to ligate it below the clot, after which it can be opened, cleaned out, and through-and-through irrigation made into the vein and out of the sinus and vice versa.



} Petro-squamosal  
suture.

Fig. 480.

Left Temporal Bone—Internal Aspect. Showing Tegmen Tympani and Petro-Squamosal Suture.—Macewen.

**Tumors of the Brain.**—Not much more than a decade ago tumors of the brain were of little interest except on the post-mortem table. But clean surgery, guided by accurate cerebral localization, has opened possibilities before not dreamed of. A number of these have been referred to in considering the various diseases and injuries of the head. As regards brain tumors, however, the outlook is not as promising as would be inferred at first thought. Only those affecting the cortex and centrum ovale are accessible; multiple tumors are usually inoperable and others, again, had better not be touched. In this way the field is restricted until by the most sanguine estimates not more than ten per cent. of brain tumors can be brought to the operating table.

**LOCATION.** Brain tumors may involve the cerebrum or cerebellum—the former predominating—the surface, or white matter, and the base, the latter and the cerebellum being the more common sites in children.

**VARIETIES.** *Tubercular.* The tubercular variety is by far the most frequent in children and more oftener met with than any other form of tumor. They are apt to be multiple and basal. They undergo the same secondary changes as elsewhere, spreading by a granulation zone and occasionally becoming encapsulated and calcifying. Basilar meningitis is a more common sequel. There is usually a tubercular history, or similar lesions are found in other parts of the body.

*Syphilitic Gumma.* In adults the syphilitic gumma probably heads the list in frequency. Other manifestations or a history of lues can often be made out. Iodide of potassium is often of great diagnostic value, but its administration should not be persisted in too long, six weeks being a fair outside limit. The author quite agrees with Bartlett as to the necessity for very large doses of this drug in late syphilitic manifestations of the nervous system. In similar lesions elsewhere, however, smaller doses alone agree and benefit.

*Glioma, Glio-Sarcoma and Sarcoma.* These varieties are the tumors of adult life, usually being met with between the ages of twenty and forty. The first named are apt to infiltrate and, being more vascular, may give rise to signs of varying intracranial pressure and to apoplectic symptoms from hemorrhage. Sarcomata are more generally encapsulated and thus less vascular. The presence of similar growths elsewhere may occasionally indicate their character, but this is more apt to be the case with growths of the skull or dura, which usually appear externally, besides making intracranial pressure. They have been referred to previously under the Skull.

*Cysts.* Cysts of the brain may be of parasitic origin, echinococcus, cysticercus and hydatid, but these are rare in this country. Hemorrhagic cysts are not uncommon in connection with gliomata. Those from hemorrhage following traumatism in the substance, cortex and meninges have been already considered and some of the symptoms they produce noted. Such hemorrhages have also been noted in connection with the various forms of nephritis. Traumatism is an important causative factor in the development of brain tumors which are not of constitutional origin or secondary.

*Carcinoma.* Carcinoma is a great rarity as a primary growth; brain metastases, however, are frequently met with and the original tumor will indicate their character.

**SYMPTOMS.** These differ to a marked degree, some cases presenting none at all, while in others they vary from time to time. As a rule, however, they are progressive. The average duration of a tumor is two years. There are some symptoms that may be said to be common to all tumors, diffuse, others being of a localizing nature and pointing to their origin focal. Of the former, headache is almost always present and an early manifestation; it is generally severe and either constant or marked by periodical exacerbations. When localized it suggests a surface growth, and an associated tenderness, from meningeal pressure. It is said to be absent in infiltrating growths. Next to headache comes cerebral vomiting, projectile in character and not dependent on digestive disturbance. Optic neuritis, as already stated, is of particular diagnostic value in tumor. It is present especially with basal growths and is usually double. Vision may not be much impaired until consequent atrophy takes place. Vertigo is another common symptom and would naturally be expected in cerebellar tumors. Mental disturbance will appear as dulness, delusions, loss of memory, peevishness and, as the tumor enlarges, stupor and coma. Occasionally symptoms suggesting hysteria are met with. General epileptic seizures, slight or severe, are not infrequent and, if focal or localized, are of the greatest value. Thus, there may be spasms always beginning in or confined to a side of the face, an arm, leg, etc.



These are of greater value than a palsy. The latter may be a hemiplegia, a monoplegia, paralysis of cranial nerves, hemianesthesia, hemianopsia, the varieties of aphasia, etc., according to the location of the tumor. In the same way there may be hallucinations or impairment of the special senses, sight, hearing, taste and smell.

**TREATMENT.** The surgical treatment of brain tumor is excision. If this be impossible, relief of tension will be of great palliative value. The benefit from removal of large areas of bone for this purpose is sometimes astonishing. Personal experience shows that such patients will return and plead for a second and third operation of the kind, while life has been prolonged, at times, beyond all expectation. The operative technique has been described under fractures. The osteoplastic method is used by some on account of the large opening necessary; the jars of the mallet, however, are said to be detrimental. Quick work with the trephine and the dexterous use of gnawing forceps will usually accomplish better results. The shock is to be dreaded but may be avoided by operating in two or even three tempos. More than one life has been saved in the author's experience by infusion of salt solution. Temporary packing of resulting cavities in the brain and secondary suture of the dura and scalp wounds are also of frequent service. Encapsulated tumors can usually be turned out by blunt dissection without difficulty. Those that infiltrate present greater difficulties. There is the desire, on the one hand, to remove all diseased tissue without which recurrence will take place, and the fear, on the other, of unnecessarily mutilating the brain. It is sometimes hard to distinguish normal brain tissue from that of the new growth, particularly when dealing with gliomata. Operations are so often negative in their results, from the difficulty of distinguishing between cortical growths and those in the substance of the brain, that this possibility should always be emphasized beforehand.

**Epilepsy.**—**VARIETIES.** Epilepsy may be divided into the symptomatic, traumatic and, for want of a more correct term, the idiopathic. The first is a symptom met with in the various insanities, occasionally with abscess and quite often with tumor, and may be localized or general. The variety of symptomatic epilepsy of the greatest interest to the surgeon is the Jacksonian. This is due to gross lesions of the cortex and may be motor, sensory, aphasic, or psychical. It is characterized by a localized spasm originating in the motor centres irritated, and spreading thence to adjoining ones, as, for instance, from the face to the arm and then to the leg. The extent of the spread will be coincident with the lesion, the symptoms shading off from the central focus as does the severity of the irritation. Should the attack go on and become general, after beginning in this localized manner, the term focal epilepsy is applied. Typically, however, consciousness is not lost in the Jacksonian form and the convulsed muscles are afterward paralyzed from exhaustion of the motor centres. Just as we find spasm and then paralysis of the muscles, so sensation is first irritated and then exhausted, the centres of tactile sense being, as already stated, the same as the motor. There are abnormal sensations, such as numbness and tingling at the onset, and these are followed by more or less complete anesthesia. The same may happen if the centres of the special senses, smell, taste, hearing and sight, are excited and then tired out, the results of which have already been mentioned. These constitute the sen-

sory form. In like manner coincident aphasia of any kind will be equally valuable in indicating the seat of lesion. This is known as the aphasic variety. An equivalent condition of intellectual disturbance is known as psychical epilepsy and points to the frontal lobes. The symptoms are temporary mental alienation or excitement, at times maniacal in character, followed by dulness or stupor, the attack and coincident occurrences being forgotten.

*Traumatic Epilepsy.* As indicated by the name, this variety has its origin in an injury, and may be general, Jacksonian of any type, or focal. The epileptic attacks may not appear for some time after the injury, months or even years, and this may have been but slight apparently and,

in fact, the seizures too are infrequent and slight at first (petit mal) and subsequently multiply and increase in intensity. Among the causes are depressed fractures, splinters of the inner plate being particularly common. In fissured fractures there is often a coincident tear of the membranes or cortex with resulting adhesions or cicatrix which seem to be the exciting cause. Again, a tender scar of the scalp is at times the seat of the aura, or



Fig. 481. Hydrocephalic Head.

pressure upon it may bring on a convulsion. In such cases the scar may be the only discoverable lesion or may lead to more important ones. Other causes of traumatic and Jacksonian epilepsy are the different forms of meningitis, whether tubercular, syphilitic, or from injury; tumors, hemorrhagic cysts, sclerotic areas, often originating in a cicatrix, or even patches of softening following embolism or thrombosis, etc.

**TREATMENT.** It should be borne in mind that the removal of a source of irritation from any portion of the body or even any operation per se will at times cure epilepsy. Again, any causative lesion must be removed as early as possible; the so-called "epileptic habit," if once well established, will otherwise continue in spite of the most thorough operation; the same is true of secondary changes, most frequently sclerotic in character, that will in time involve large extents of the brain. The attempt should be made to produce no lesions which in themselves might serve as irritants; hence wound-healing must be aseptic, brain incisions must be made so as to heal with a minimum of scar tissue, and adhesions must be



prevented. The last can often be accomplished by the use of gold-foil, referred to before. Furthermore, lesions should be excised with the utmost thoroughness; the resulting paralysis has been shown to be temporary, other centres in the neighborhood soon compensating. Personal experience would lead the author to advise that complete disappearance of the paralysis should not be promised. Even though much is done in a compensatory way the restoration is not usually complete. In case an exploratory operation proves negative, by using a double pointed electrode and faradizing the cortex with a mild current the desired motor centres can be accurately located and then excised. The points of the instrument should be sterilized; sublimate solution, which would dull the reaction of the cortex to the current, is, as already stated, not to be used after the dura is opened, except in septic cases. The operative steps must be guided by lesions and, when they do not correspond with the localizing symptoms, by the latter always. A tender scar of the scalp had better be excised, especially if the skull underneath is normal. A point often overlooked is that the same treatment, hygienic, dietetic and medicinal, as would be used in cases that are not operated should be carried out for a long time after operations.



Fig. 482. Hydrocephalic Skull.

**Hydrocephalus—Headache—Insanity.**—These constitute a few other conditions for which operative measures have been suggested and tried.

Hydrocephalus or dropsy of the brain, may be acute or chronic. The former is almost always of tubercular origin, the fluid being either in the ventricles or extra-ventricular. It belongs rather to the realm of medicine, as surgical measures do not seem to offer any hope. Tapping the ventricles by the route referred to under ventricular hemorrhage has hitherto been unsuccessful. The chronic form is usually congenital and produces the well-known distended head and concomitant symptoms. (Fig. 481). Appearing later it may be due to pressure by a tumor upon the veins of Galen, causing serous effusion into the ventricles. The resulting symptoms will be those of tumor. The sutures having united, the changes in the shape of the skull will not be present. The congenital variety has been treated by tapping the ventricles through the widely dilated anterior fontanel, a little to one side of the median line in order to avoid the longitudinal sinns; the fluid must be drawn off slowly, only an ounce or two at a time. Deaths in consequence have been common. A successful result after trephining at the side of the head by the above mentioned route has been recorded. To be sure of avoiding the lateral sinus the opening may be made, as already stated, an inch and three-quarters instead of an inch and a quarter above Reid's base line.



Attempts have been made to draw off the fluid from a distance by opening the theca of the spinal cord. Success has followed the opening of the basal sub-arachnoid space. The occipital bone is opened below the superior curved line and to one side of the middle line. The exposed cerebellum is raised, the sub-arachnoid space opened with a probe and drained with a horse-hair.

The skull has been opened for strictly localized headache which was evidently of traumatic origin. The success following the operation seems to justify it when the indications are clear.

Another condition is the insanity directly traceable to an injury. Improvement has followed the removal of lesions but has usually been but temporary.

SECTION XVII.  
**SURGERY OF THE SPINE AND CORD.**

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CHAPTER I.  
**DISEASES OF THE SPINE AND CORD.**

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**Spina Bifida.**—This is a congenital deformity of the spine of not infrequent occurrence and due to arrested development and failure of the laminae to coalesce in utero. This defect may involve one, but more frequently two or more vertebrae. Through this the membranes of the cord are extruded. In some cases the cord itself is included in the hernial mass. Such congenital defects of the vertebrae have, in rare instances, been reported as occurring in the anterior surface. Sometimes the defect in the bone exists without protrusion or other visible local sign except,



Fig. 483.—Spina Bifida.

perhaps, that the skin may be somewhat depressed and puckered and covered with a circumscribed patch of hair over the spinal column, at the level of the lesion. It is known as spina bifida occulta. The cord is likely to be impinged upon even in this variety, for the plantar and patella reflexes may be lost, and paralysis—motor and sensory—and vesical incontinence have been associated.

The protruding spina bifida usually occurs in the lumbar or lumbo-sacral region. It varies in size from that of the end of the thumb to that of a cocoanut. The skin is sometimes the overlying covering to the tumor; at other times the surface has a raw, reddened or translucent appearance.

In rare cases where the opening is small a diminution and gradual closure of the neck of the sac occurs, and the cord has no longer any communication with the tumor. It is then known as pseudo spina bifida.

When the hernia is composed of membranes and cerebro-spinal fluid it is known as a meningocele, but when to this there is added a portion of the cord the term meningo-myelocele is employed. If, with this protrusion, the same fluid distends the central canal of the spinal cord, the condition is known as syringo-myelia. The meningo-myelocele is of more frequent occurrence than the other varieties.

**DIAGNOSIS.** Spina bifida is easily diagnosed. It is quite likely to be associated with other congenital defects, such as paralysis of certain groups

of muscles of the lower extremities, hydrocephalus, mental impairment, cleft palate and hair lip. Crying, straining and the upright position are apt to increase the tension and bulging of the sac. The fluid contents may sometimes be reduced by taxis, though such a procedure may cause convulsions from the increased intracranial pressure. The bulging is nearly always in the median line, although it may vary in shape. The margins of the bony defect can sometimes be felt with the finger. When the sac is translucent the nerves may be seen passing through it. The meningo-myelocele is generally associated with muscular paralysis and atrophy of the legs and weakness of the sphincters. The cord is likely to be within the sac when a navel-like depression is seen just posterior to the anus.

**PROGNOSIS.** The outlook is unpromising. The tumor generally grows larger, and the sac may ulcerate and allow the cerebro-spinal fluid to escape. This in itself may prove fatal, but, when it is not, is likely to lead to infection and fatal inflammation of the meninges. Either from this or from some of the associated lesions by far the greater number of these children die.

**GENERAL TREATMENT.** The general course is to wait till the child is a few months old before any operative measures are contemplated. In the meantime the tumor is protected with a circular cushion with a depression in its centre—or a hole through it, or a cup-shaped and well-padded guard made of wire may be kept applied in such manner as to make slight pressure as well as to afford protection. Collodion is sometimes applied for the same purpose. Beyond such simple measures as may be carried out by the housewife, many cases receive no treatment and no other is indicated in those who give evidence of a number of associated lesions due to arrested development. If any improvement follows such palliative treatment as pressure and bandaging it should be persisted in, although the chances of a spontaneous cure are few indeed.

**OPERATIVE TREATMENT.** This consists of excision. The first step is to make an elliptical incision, leaving enough cutaneous margin to meet after removal of the sac, which is done after liberating the sac by dissection, down to its base or neck. If small it may be ligated and removed; if too large for ligation it should be removed, leaving only enough to permit of coaptation and suture of the serous surfaces. In the meningo-myelocele the posterior portion of the sac may have nerves attached to it. These should be separated carefully from the sac, deposited in the vertebral canal, the dura united with sheep-gut, and the cutaneous wound closed and dressed in the ordinary way. It is wise to have the line of coaptation in either the dural or cutaneous sac somewhat laterally to the median line, as there is less likelihood of a fistula than if one incision lies exactly above the other.

In some instances the muscles, lying laterally to the spine, have been loosened and bridged over the defect.

Successes have been reported, too, after loosening strips of bone with chisel or rongeur, turning them toward each other and then uniting the wound in the soft structures.

**INJECTION.** The injection of iodine gr. x, iodide of potassium, gr. xxx, glycerine  $\frac{3}{4}$  I (Morton's fluid) has been used quite extensively and with a fair degree of success, but at the present time does not seem to afford as good results as excision.



After a thorough surgical cleansing of the skin and hypodermic needle the latter is introduced and a couple of drachms of the cerebro-spinal fluid withdrawn from the sac. Then a half drachm or a drachm of the iodo-glycerine solution is introduced through the lateral aspect of the tumor. After withdrawal of the needle the puncture should be dried and covered with collodion. The patient should be carefully watched to insure against the escape of cerebro-spinal fluid. The injection may be repeated within a week or two if necessary.

**Congenital Sacro-Coccygeal Tumors.**—These are rare and consist of cysts, perhaps dermoids, and lipomata, and occur much oftener in girls than in boys. They are thought to have some relation to the post-anal gut of fetal life. They lie anteriorly to the coccyx, may crowd the genitals forward, the coccyx backward, and may vary in size from that of a cocoanut down to a marble. The treatment is complete extirpation, which may demand the exercise of caution on account of the juxtaposition to the bowel.

**Fetal Tumor.**—This usually consists of a leg or even two, deformed and fused, attached to the region of the sacrum. The tumor may be composed of other structures. It should be removed when the attachment is such as will permit.

**Tumors of the Spinal Cord.**—**DESCRIPTION.** The most common varieties of spinal tumors are the fibromata and sarcomata. They may spring from the arachnoid or dura, never attaining a large size on account of the bony limitations of the canal. Such growths are damaging because of their compressive influence, and not from their infiltrative or destructive tendency, as their attachments may be slight. The intra-medullary growths are more likely to be infiltrative. Carcinomatous tumors of the cord are quite likely to be secondary to the occurrence of the same variety of neoplasm in some other portion of the body.

Tubercular, gummatous and parasitic masses are occasionally found, as are lipomata and myxomata. Extra-dural growths, consisting of osteomata springing from the vertebræ and those that reach the cord through the inter-vertebral foramina, are met with from time to time. Growths of the spinal cord have been found most frequently in the region of both the superior and inferior dorsal vertebræ, and in the lower portion of the cervical region.

**SYMPTOMS.** These consist essentially of pain and motor and sensory paralysis. Pain manifests itself early, but is gradual in its onset, somewhat indefinite at first and may readily be regarded as myalgia, lumbago or rheumatism. It is shooting and burning in character, is aggravated by motion, generally shoots along the course of the nerves, is more frequently unilateral than bilateral and is referred to a point somewhat lower than the tumor. The site of the tumor or a little below it is tender to pressure. Accompanying the pain, which at times is fixed, there seems to be a local spinal weakness which is augmented by muscular effort.

The motor and sensory symptoms require careful study. Unless a hemorrhage (hemato-myelia) or an acute inflammation of the cord (myelitis) occurs, the motor paralysis will manifest itself gradually and before the sensory, its course being generally descending. With the sensory paralysis the reverse is true, its course being from the periphery toward

the vertex. There is muscular rigidity of the back, or of the side, and in the latter case a certain amount of lateral curvature of the spine occurs from the muscular contraction. Such unilateral contraction takes place upon the same side occupied by the tumor. This rigidity accompanies the intra-dural growth much more frequently than the extra-dural.

The reflexes are exaggerated at first but are usually absent later. There is sometimes hyperesthesia and paresthesia, numbness, pricking and tingling in the back, such sensations being situated in the region of the tumor, with perhaps a tendency to encircle or girdle the trunk. Multiple tumors of the cord lend an element of confusion to the localizing symptoms.

Brachial and pupillary symptoms are present when the tumor is located respectively in the cervical region and at or above the second dorsal vertebra. The pupil on the affected side will be smaller than its fellow.

Tumors of the dorsal region are usually sensitive to percussion. Cough, dyspnea and atrophy of brachial muscles may be associated with the cervical growth. Paralysis of both rectum and bladder and either incontinence or retention, cystitis and bedsores are frequent symptoms.

DIAGNOSIS. Early diagnosis is often difficult or impossible. It must be based upon the pain—radiating and localized—tenderness and local weakness aggravated by muscular effort, and the motor and sensory paralysis. Pre-existing carcinoma or syphilis would naturally lead to the suspicion that the cord had become involved from such systemic disturbance. Otherwise little can be foretold as regards the variety of the growth. The treatment is removal by laminectomy, which is described on page 732.

PROGNOSIS. From the symptoms just enumerated it will be evident that the prognosis is bad, the patient usually becoming progressively worse, eking out a repulsive existence for perhaps one or more years. Unless the growth be of the gummatous variety which may yield to anti-syphilitic treatment, the only relief is by operation

## CHAPTER II.

### INJURIES OF THE SPINE AND CORD.

---

**Sprains and Contusions.**—These are generally combined as regards occurrence, and may, therefore, be studied together.

They usually result from falls, blows from falling objects, and the severer varieties from railroad accidents.

**PRIMARY SYMPTOMS.** The symptoms vary with the severity of the injury but present the usual local symptoms—soreness, stiffness, lameness and swelling; and at times ecchymosis. Shock and hematuria may likewise occur. Ecchymosis may appear some hours after the accident, the ecchymotic area being large or small, according to the extent of the injury. Like wounds of the same variety in other locations they may be attended with hematoma. Hematuria may be indicative of a rupture, either slight or severe, of the kidney. When there has been marked wrenching of the vertebral column it may result in extra- or intra-dural hemorrhage, and muscular rigidity is quite likely to be noted, the patient striving involuntarily to hold the injured vertebral column in a state of quiescence by means of the rigid muscles.

*Treatment.* This should consist first of the treatment of the shock, which is given in another chapter, the putting of the patient at perfect rest, and the administration of arnica, rhus tox., bryonia, aconite, etc., according to the symptoms.

The patient should be watched to see that retention of the urine, if it occurs, is relieved. The bowels may likewise require attention. Hot applications to the traumatized area sometimes afford relief. Partial immobilization of the trunk is also useful. If the injury is bilateral the adhesive straps may be applied over the back and sides, or by overlapping one side of the spine and sternum if the injury is unilateral. A paper or plaster jacket is sometimes employed for the same purpose. Later, massage and electricity may be found useful.

**SECONDARY SYMPTOMS.** The secondary symptoms of spinal contusions or sprains are practically synonymous with the so-called railway spine, railway back and litigation symptoms, and are likely to be much more troublesome than the primary. These terms are applied to conditions resulting, apparently, from the impression made upon the nervous system, rather than to any tangible physical lesion, such as a fracture or dislocation of the spine. Such symptoms are extremely variable and possess a high degree of medico-legal importance. It is presumed that the shock or terror naturally associated with railroad accidents is the essential cause of the nervous phenomena which occur subsequently. They follow slight as well as severe injuries. In a frightful railroad accident (to which is added the danger of fire or drowning, the horror of the surrounding injured, dead and dying) the man who may be apparently free from injury—or perhaps only slightly injured—is the one in whom secondary symptoms may appear, instead of the one who may have been more



severely injured and perhaps rendered unconscious. This is not always the case, but has occurred with sufficient frequency to establish the fact that the symptoms are not necessarily in proportion to the physical injury. Nervous depression, hysteria, fright and shock frequently subside with the other acute symptoms, but the later forms of traumatic hysteria and neurasthenia are more or less ominous. Motor and sensory symptoms are prominent, as shown by the inability to move certain portions of the body or limbs, accompanied by hyperesthesia, anesthesia or paresthesia of the thighs and legs. The back is moved with difficulty, is stiff and lame, or curved to one side, there are vague pains and points of tenderness here and there. Spinal rotation is difficult, the legs tremble, asthenopia supervenes, the voice is weak, speech jerky, the skin moderately or extremely moist, the urine profuse and voided frequently at night, there is mental anxiety, confusion and lack of concentration, foreboding, gloominess and depression. In some cases there are epileptiform attacks, in others contracted limbs. The surgeon will remember that in this affection, like all others which have such a wide range of symptoms, there is much variability as to which group may be mild or severe. Numerous cases are on record where such symptoms have been present without any associated litigation, yet these are termed litigation symptoms. Their occurrence, however, without a lawsuit, is presumptive evidence that they are not feigned. So many of them are subjective that simulation has undoubtedly been practiced in litigation cases. Nor does the subsidence of the symptoms after the recovery of damages by law necessarily indicate fraud. For the ending of the more or less painful suspense of litigation, which is well calculated to perpetuate many of the nervous phenomena complained of, and the acquisition of what may appear to the injured person like a small fortune may have a curative influence.

The examination of such patients often requires the keenest discrimination, as it is difficult to determine whether the case is one of genuine suffering or of simulation. When a patient claims to have failing memory, sight and speech, insomnia, vague pains, sensitive spots, paresthesia, etc., it may be difficult for the clinician to disprove the claim, even though it be a fraud. When, however, the patient is injured sufficiently to suffer from hematuria, hematemesis and extreme moisture of the skin, these may be regarded as *bona fide*.

A suspected malingerer will usually display a desire to exaggerate—he is as likely as not to complain of deep pains and tenderness at points remote from the site of the injury, and of superficial pain and tenderness over the injured area, (the reverse should be true) and the purported immobility of a limb or portion of the spine may sometimes be disproven by distracting the attention with the motion of one or two other limbs or a part of the trunk, and simultaneously making an attempt to move the alleged immobile part. He is also likely to complain of pain from the supposed electrical current, even when the electrode and cord, unseen by him, have been separated and held in the palm of the hand. The claim of insomnia may be decided if the patient can be placed under close watch. The simulator cannot display a local muscular rigidity, such as a spasm of the erector spinæ. Lateral, posterior and anterior flexion of the spine, as well as rotation of the head and shoulders, and sudden

pressure upon the latter, will test the sensitiveness of the inter- and peri-vertebral structures.

*Treatment.* The most important feature in the treatment is mental and physical rest. Some aid may be obtained from such remedies as arnica, rhus, actea racemosa, pulsatilla, bryonia, gelsemium, etc. The patient should not be allowed to worry over business problems, should be protected from friends, and his mental anxiety and apprehension quieted. The suspense, excitement, worry and nervous strain of a lawsuit should be guarded against and a private settlement be advised instead. The sore, or lame back or shoulders may be supported as advised for the acute symptoms. Massage, electricity and perhaps the "rest cure" or its modifications may be advisable. The care of the catheter need scarcely be urged here, in cases of retention. With the lapse of time any disposition on the part of the patient to assume the physical habit of quiescence, dwelling upon his complaints, and reluctance to make the least effort toward convalescence, should be combatted by travel, change of scene and surroundings and mental and physical occupation to a reasonable degree.

**Open Wounds of the Spine and Cord.**—Shot, shell, bayonets, knife-blades, etc., are the usual causes. Such wounds can be inflicted only by first wounding the back or peri-spinal structures, which may in itself be of no little importance, as for example, the wounding of the vertebral or occipital arteries.

**SYMPTOMS.** The symptoms must necessarily vary, depending upon the extent and location of the wound. If the supra-spinal structures, ligaments, vertebral cartilages and periosteum only are injured, the symptoms would naturally be those of a similar wound in other localities. If the vulnerating body penetrates the spinal canal, lacerating the cord, or even its membranes, cord symptoms will ensue. There will be escape of cerebro-spinal fluid which—even in those rare instances in which the ureter or renal pelvis may be simultaneously wounded—can be differentiated from urine by its steady drip, absence of urinary odor, and microscopical deposits. Complete paralysis ensues if the cord is severed or destroyed. If the cord injury be unilateral there will be motor paralysis of the injured side and sensory paralysis of the other.

The usual primary retention of urine, with perhaps incontinence later, may be looked for in cases of cord injuries. Bed sores are also common accompaniments.

**TREATMENT.** If a wound is inflicted in the cervical region the vertebral artery may be injured and hemorrhage, either primary or secondary, may be grave. Such arterial traumatism may likewise be followed by an aneurism, for the relief of which the carotoid has been tied by mistake. At the time of the injury the wound may be enlarged and the artery caught and ligated, or packing and pressure may be all-sufficient. The same rules that govern the treatment of wounds elsewhere apply here—thorough disinfection around and within the wound, removal of the vulnerating body, hemostasis, deep and superficial coaptation, immobilization, etc.

The injury may be such as to require laminectomy. Direct injury of the cord is more or less grave, but its regenerative power after accidental,



or even operative wounds is sometimes surprising. Numerous cases of partial severance of the cord have been followed by recovery.

**Dislocations of the Spine.**—As already seen, dislocations of the spine occur less frequently singly than in combination with fracture, the amount of force required to produce the former usually being sufficient to produce the latter. They occur oftenest in the cervical region, only occasionally in the dorsal, and with extreme rarity in the lumbar region. The causes are falls upon the head, forced flexion, extreme lateral flexion, hanging, etc. The upper vertebra is regarded as the one displaced, whatever may be the location of the injury.

**DISLOCATION OF OCCIPITAL BONE FROM ATLAS.** Only a few cases of this accident are recorded. Both speech and deglutition are difficult and the chin sinks upon the chest. Compression of the medulla usually causes death. The treatment should consist of traction and steadying the head and neck by sand bags or other immobilizing dressing.

**DISLOCATION OF ATLAS FROM AXIS.** This occurs with far greater frequency than the preceding variety. The odontoid process may slip from the grasp of the ligament, which, with the check ligaments, may be torn. Here, too, death is frequent from pressure upon the medulla.

*Symptoms.* There are severe pain and rigidity, or perhaps mobility of the head, prominence of the spine of the axis, bulging of the atlas into the pharynx may be demonstrated, and usually flexion of the chin upon the chest. Death may be immediate or may occur subsequently from additional displacement occurring with movements of the patient. The treatment is traction, manipulation and immobilization.

**DISLOCATION OF THE FIVE LOWER CERVICAL VERTEBRÆ.** Fracture-dislocation is not infrequent in this region. Probably the fifth cervical is the most common site of dislocation. The forward displacement, both bilateral and unilateral, occurs with more frequency than the other varieties. The displacement may be lateral, posterior—unilateral or bilateral—or it may be a simple separation.

*Symptoms.* When there is bilateral forward dislocation, besides the usual pain aggravated by the least attempt at movement, the head is fixed and bent to one side and backward, or forward or backward. There is irregularity of the transverse processes. The larynx projects forward and a bulging in the pharynx may be noted (Fig. 484). The cord symptoms have already been dwelt upon. The prognosis is unfavorable.

The symptoms of unilateral forward dislocation are local pain and tenderness, prominence on the dislocated side, deviation of the spinous processes, pharyngeal deformity, and the posture seen in Fig. 489. The face is usually turned away from the dislocation. The muscles on the dislocated side are tense, those on the opposite side relaxed. Both the upper and lower extremities are paralyzed when the cord injury is below the fourth cervical vertebra.

The treatment ordinarily employed is traction and manipulation.



Fig. 484.  
Forward Dislocation of  
the Fifth Cervical  
Vertebra.



Walton advises against traction and says: "Perform retro-lateral flexion in the direction toward which the face is turned by the dislocation; then rotate back into place." The head and neck are then immobilized and the patient may be fed through a bent glass tube.

**DORSAL AND LUMBAR DISLOCATIONS.** These are rare and in most instances in which they occur they are between the twelfth dorsal and first lumbar.

The symptoms are angular spinal deformity, paralysis below and hyperesthesia at a level or a little above the dislocation, and a sub-normal temperature.

Differential diagnosis between fracture and dislocation in this region is not always possible.

*Treatment.* The patient should be laid upon a firm table, or the floor, and traction and counter-traction applied. The legs and thighs are pulled downward, the head and arms upward. This failing, the trunk may be immobilized by plaster dressing to prevent further injury to the cord. The attempts may be repeated, but are sometimes unsuccessful, in which case there is a liability to pulmonary hypostatic congestion, pneumonia, bed-sores, cystitis and the usual train of compressive cord symptoms. An irreducible dislocation in this region, with persistent symptoms of pressure upon the cord, justifies laminectomy.

Wiring of the vertebræ has not been done extensively, and up to the present time may be regarded as uncertain in its results. The wires are passed through the inter-vertebral foramina in some instances (Fig. 486) and between the spines in others (Fig. 485), and in some cases between the transverse processes.

**Laminectomy.**—Laminectomy, or removal of the vertebral laminae, is performed mainly for the relief

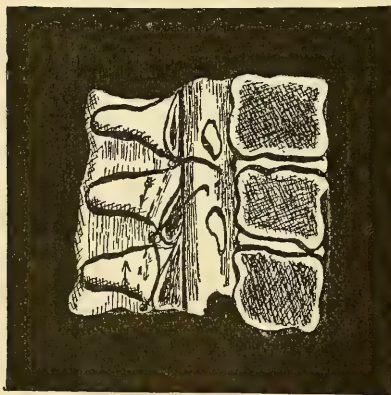


Fig. 485

Wiring by the Inter-Spinous Method.

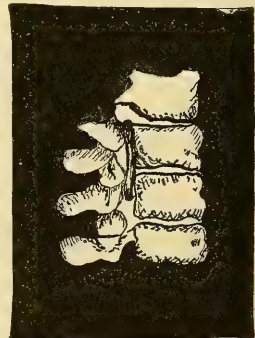


Fig. 486.

Wire Passed through Inter-Vertebral Foramina.

of pressure upon the cord. While the causes of the pressure may vary greatly—as, e. g., Pott's disease, fracture, dislocation, tumors, wounds, foreign bodies, adhesions, etc.—the steps of the operation are practically the same. The patient and the oper-

ative field should be prepared with care and with the appreciation of the fact that the operation is very likely to be attended with extreme shock, and the usual methods should be employed for its prevention. The dangers and difficulties which may be encountered are shock, hemorrhage, anesthesia, sepsis, difficult or impossible reposition and apposition of vertebral fragments, possible destruction of the cord and difficulty of clearing the canal. Besides the ordinary instruments there will be needed a

small trephine, a dozen and a half or two dozen artery forceps, raspatories, retractors, rongeur forceps, bone pliers, sequestrum forceps, etc.

The patient lies upon the side, or in Sims' position, and the anesthetist should be more than usually watchful, as the respiratory paralysis adds much to the danger from the anesthetic. Inasmuch as it is often neces-

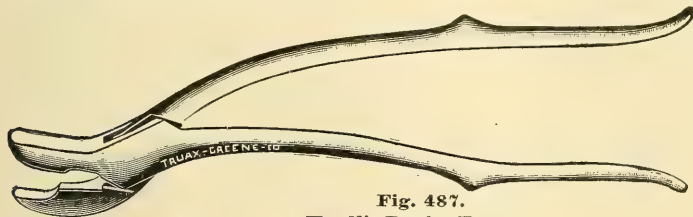


Fig. 487.  
Knoll's Raphe Forcep.

sary to remove from two to six arches quite a free incision should be made. Its initial length may vary from five to eight inches. Some

employ the single median incision, others the V, T, H or U shaped incision. One of the latter is employed with the osteoplastic resection, which consists of the section and raising of the arches with the musculo-cutaneous flaps, and afterward replacing them—with the bony edges trimmed—in their former position. The muscles are severed from the spinous processes and laminae, first upon one side, which is then packed with hot gauze pads, while the muscles upon the other side are treated in a similar manner. These steps may require some rapidity, as the hemorrhage is sufficiently free to demand attention. The larger vessels can be caught with forceps, the remainder of the dissection being hurriedly completed, when the bleeding can be more readily controlled. After the spine is well exposed the spinous processes may then be removed. The line of division should be close to their bases and will require heavy angular bone forceps. The laminae being thus exposed, are divided with the rongeur or other bone forceps (Figs. 487 and 488) according to preference, close to the transverse processes. Some open the canal with the small trephine.

The dura, being exposed, is examined carefully. A blood clot may be found lying upon it, or beneath it, which will show through, giving the dura a purplish or dark look. If pus is suspected from the yellowish hue of the dura, or if there be reason to suspect other sub-dural lesions, then the dura should be incised and the cord exposed. The durais picked up carefully with fine-toothed forceps, knicked and cautiously slit, upward and downward, as far as necessary. After being thus divided it may be drawn aside and the posterior surface of the cord inspected. A bent probe or other curved and blunt instrument can be passed beneath the cord and the sub-dural or antero-lateral spaces be examined. If a tumor of the cord is discovered it is removed, unless it be of the infiltrative variety, which is inoperable. In cases of fracture or displacement the offending vertebra will be attacked and splinters of bone removed. A gauge, chisel or rongeur should be used when there is sufficient displacement to produce irregularities which impinge upon the cord. The latter should be drawn aside if necessary and the irregularity gnawed or chiselled away. When the operation is completed the dura is



Fig. 488.  
Gnawing Forcep.



coapted carefully and united with fine sheep-gut sutures about one-eighth of an inch apart. The ends are cut short, a few strands of sheep-gut or silk-worm suture may be left in the lower angle of the wound, the muscles next united by buried suture, and the aponeurosis and skin united in the usual way.

**Fractures of the Spine.**—Vertebral fractures are quite rare as compared to the frequency of fractures of the long bones. They occur most frequently in the male, during middle life, and are caused by either direct or indirect force. The vertebræ oftenest involved are the fifth and



Fig. 489.

Unilateral Injury to Fifth Cervical Nerve.

sixth cervical, the last dorsal and the first lumbar. Both the body and arches are fractured, although the former is the more liable. Forced flexion, falls from a height, the caving in of embankments, railroad accidents, gunshot wounds, etc., are the common causes. There is

often displacement accompanying the fracture (fracture-dislocation), as well as laceration of ligaments and muscles, hemorrhage into the canal and possibly injury to the cord.

**SYMPTOMS.** Pain, aggravated by motion, local tenderness and ecchymosis, motor and sensory paralysis, priapism, cystitis, phosphatic urine and retention are the common symptoms. If the fracture with dislocation occurs in the cervical region the distortion is obvious. Angularity and deviation from the normal line formed by the spinous processes can sometimes be demonstrated, and if these latter are fractured crepitus may be detected; otherwise it is somewhat rare.

With fracture of the upper cervical vertebræ there is even greater danger of death from apnea because of the paralysis of the diaphragm and intercostal muscles, indicating damage to the phrenic nerve or medulla oblongata. It is not uncommon for the fifth cervical nerve to be injured at the same time. In such cases, if the injury is unilateral, the patient may be expected to assume a position as is shown in Fig. 489 (Thorburn). Fractures of the atlas and axis, like the preceding, may be attended by primary apnea and death from pressure or destruction of the respiratory centre. In general it may be said that the nearer the site of the injury to the vertex the graver the prognosis. The axis is more frequently fractured than the atlas, and at times the odontoid process alone may be fractured. In the latter case the head and neck are fixed more or less rigidly. If there is associated displacement forward there may be marked bulging of the larynx.

Fracture of the lower cervical region is attended with partial or complete paralysis of the upper extremities, marked dyspnea and diaphragmatic respiration, priapism, weak phonation and possibly hyperpyrexia, the temperature having been noted as high as 110 degrees and even 120 degrees, with recovery. The prognosis is very grave on account of the liability to primary apnea or secondary myelitis.



The higher the location of the dorsal fracture the higher the paralysis will extend. If it occurs in the upper portion of the dorsal region there will probably be impairment of the intercostal muscles and consequent dyspnea. The voice is weak, the skin scaly or branny, and the bowels tympanitic.

Many of the symptoms first mentioned are common to a majority of the fractures of the spine, but may be lacking, e. g., in the three lower lumbar vertebræ, for the reason that the cord terminates in the cauda equina before it reaches this point, and because they are surrounded with such a dense mass of muscular supports. The characteristics of such a fracture, therefore, may be only those of a contusion—local tenderness, pain and difficulty in standing or walking. This is a rare fracture and the prognosis is good. Fracture-dislocation above this point, say, of the twelfth dorsal or first lumbar, will be attended with paralysis and involvement of the bladder and rectum. The prognosis is guarded.

**DIAGNOSIS.** To a considerable extent the symptoms as enumerated form the basis of diagnosis in fractures of the spine. It is important to note the height of the paralysis at the time of the injury, or at the first examination, for it will increase with an associated spinal hemorrhage or a subsequent myelitis. A study of the limitations of the motor and sensory paralysis and the reflexes with special reference to the segments of the cord will aid in a more definite localization of the lesion. To determine the level of the cord injury, the following Starr-Mills table is helpful, although not regarded as free from inaccuracies:

**LOCALIZATION OF THE FUNCTIONS OF THE SEGMENTS  
OF THE SPINAL CORD.**

(In this table of localization of the functions of the segments of the spinal cord, it may be suggested by way of explanation, in the first column are given the various segments of the cord; in the second column are given the muscles supplied by the nerve or nerves arising from each segment; and in the fourth is given the area of sensation or, in other words, the area of skin supplied by such nerves.)

BY STARR. MODIFIED BY MILLS.

SEGMENT.	MUSCLES.	REFLEX.	SENSATION.
Second and third cervical.	Sterno-Mastoid. Trapezius. Scaleni and neck. Diaphragm.	Hypochondrium (?), third to fourth cervical. Sudden inspiration produced by sudden pressure beneath the lower border of ribs.	Back of neck and of vertex. Occipitalis major, occipitalis minor, auricularis magnus, Superficialis coli and supraclavicular.
Fourth cervical.	Diaphragm. Deltoid. Biceps. Coraco-Brachialis. Supinator longus. Rhomboid. Supra- and infra-spinatus.	Pupillary (fourth cervical to second dorsal). Dilatation of the pupil, produced by irritation of neck.	Neck. Shoulder, anterior surface. Outer arm. Supraclavicular, circumflex, musculocutaneous or external cutaneous.

Fifth cervical.	Deltoid. Biceps. Coraco-Brachialis. Brachialis anticus. Supinator longus. Supinator brevis. Deep muscle of shoulder blade. Rhomboid. Teres minor. Pectoralis (clavicular part). Serratus magnus.	Scapular (fifth cervical to first dorsal). Irritation of skin over the scapular produces contraction of scapular muscles. Supinator longus (fourth to fifth cervical). Tapping the tendon of the supinator longus produces flexion of forearm.	Back of shoulder and arm. Outer side of arm and forearm to wrist. (Supraclavicular, circumflex, musculo-cutaneous or external cutaneous, internal cutaneous, radial).
Sixth cervical.	Biceps. Brachialis anticus. Subscapular. Pectoralis (clavicular part). Serratus magnus. Triceps. Extensors of wrist and fingers. Pronators.	Triceps (sixth to seventh cervical). Tapping elbow tendon produces extension of forearm. Posterior wrist (sixth to eighth cervical). Tapping tendons causes extension of hand.	Outer side and front of forearm. Back of hand, radial distribution. Chiefly musculo-cutaneous or external cutaneous, internal cutaneous.
Seventh cervical.	Triceps (long head). Extensors of wrists and fingers. Pronators of wrist. Flexors of wrist. Subscapular. Pectoralis (costal part). Serratus magnus. Latissimus dorsi. Teres major.	Anterior wrist (seventh to eighth cervical). Tapping anterior tendon causes flexion of hand. Palmar (seventh cervical to first dorsal). Stroking palm causes closure of fingers.	Radial distribution in the hand. Median distribution in the palm, thumb, index and one-half middle finger. Musculo-cutaneous or external cutaneous, internal cutaneous, radial, median.
Eighth cervical.	Triceps (long head). Flexors of wrist and fingers. Intrinsic hand-muscles.	.....	Ulnar area of hand back and palm, inner border of forearm. (Internal cutaneous, ulnar).
First dorsal.	Extensors of thumb, intrinsic hand-muscles. Thenar and hypothenar muscles.	.....	Chiefly inner side of, forearm and arm to near the axilla. (Chiefly internal cutaneous and nerve of Wrisberg or lesser internal cutaneous).
Second dorsal.	.....	.....	Inner side of arm near and in axilla. (intercosto-humeral).

Second to twelfth dorsal.	Muscles of back and abdomen. Erectores spinæ.	Epigastric (fourth to seventh dorsal). Tickling mammary region causes re- traction of the epigastrium. Abdominal (seventh to eleventh dorsal). Stroking side of abdomen causes retraction of belly.	Skin of chest and ab- domen. in bands running around and downward, corre- sponding to spinal nerve. Upper gluteal region (intercostals and dorsal posterior nerves).
First lumbar.	Ilio-Psoas. Rectus. Sartorius.	Cremasteric (first to third lumbar). Stroking inner thigh causes re- traction of belly.	Skin over groin and front of scrotum. (Ilio-hypogastric, ilio- inguinal.)
Second lumbar.	Ilio-Psoas. Sartorius. Quadriceps femoris.	.....	Outer side of thigh. (Genito-crural, ex- ternal cutaneous).
Third lumbar.	Quadriceps femoris. Anterior part of biceps. Inward rotators of thigh. Abductors of thigh.	Patellar (third to fourth lumbar). Striking patellar tendon causes ex- tension of leg.	Front of thigh. (Middle cutaneous, in- ternal cutaneous, long saphenous ob- turator).
Fourth lumbar.	Abductors of thigh. Adductors of thigh. Flexors of knee. Tibialis anticus. Peroneus longus.	Gluteal (fourth to fifth lumbar). Stroking buttocks causes dimpling in fold of buttock.	Inner side of thigh, leg and foot. (Internal cutaneous, long saphenous, ob- turator).
Fifth lumbar.	Outward rotators of thigh. Flexors of knee. Flexors of ankle. Peronei. Extensors of toes.	Achilles tendon (fifth lumbar to first sac- ral). Over-exten- sion causes rapid flexion of ankle. called ankle-clo- nus.	Back and outer side of leg, sole, dorsum of foot. (External popliteal, external saphenous, musculo-cutaneous, plantar).
First and second sacral.	Flexors of ankle. Extensors of ankle. Long flexor of toes. Intrinsic foot- muscles.	Plantar (fifth lumbar to second sacral). Tickling sole of foot causes flexion of toes and retrac- tion of leg.	Back and outer side of leg, sole, dorsum of foot. (Same as fifth lum- bar).
Third, fourth and fifth sacral.	Gluteus maximus. Perineal. Muscles of bladder, rectum and exter- nal genitals.	Vesical centres. Anal centres.	Back of thigh, anus. perineum, external genitals. (Small sciatic, pudic, inferior hemor- rhoidal, inferior pu- dental).
Fifth sacral and coccygeal.	Coccygeus muscles.	.....	Skin about the anus and coccyx. (Coccygeal).



**Gunshot Fractures of the Spine.**—These are uncommon except in war. The damage to the vertebræ—and consequently to the cord—is likely to be greater than in the previous forms of fracture because of the

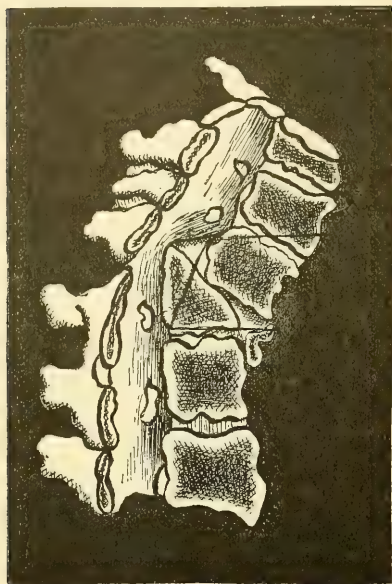


Fig. 490.

Fractured Vertebra Displaced and Making Pressure on Cord.

splintering force of the bullet. What also adds a fatal tendency is the associated wounding of important viscera by the same missile which may reach the vertebræ through the viscera or vice versa. Bullets frequently find lodgment in the vertebræ, as in the Garfield case. (Figs. 491, 492.)

The symptoms and diagnosis do not differ materially from those previously enumerated, except in the addition of the open wound. Whether the cord is injured or not will be determined as above, but the extent of the injury to the vertebræ themselves may be impossible to determine. Investigation either with finger or probe may be valueless on account of the depth of the injury. The importance of the utmost degree of antisepsis cannot be overestimated here.

**TREATMENT.** The prognosis is grave. The indications for operation are the same as in fracture. To the

contra-indications are added the wounding of other important structures. If such exist and are liable to prove fatal operative measures are, of course, precluded. In the absence of such conditions, and when there are symptoms indicating pressure from a blood clot, the missile, or the osseous fragments, operation is indicated. Even if the bullet is lodged in the canal death is so certain from the usual train of distressing symptoms, that operation can scarcely add in the least to the gravity of the case. An exploration should be regarded as justifiable in almost any case lacking the positive characteristics of non-operative conditions. The enlargement of the wound and the discovery of the character and extent of the traumatism may be accompanied by the removal of the foreign body, fragments of bone or blood clots which were otherwise sure to be fatal.

**Treatment of Fractures in General.**—The prompt care, handling and transportation of the patient immediately after the injury are important. Unless the spine is more or less immobilized by sand bags to the sides, or, in cervical fractures, to the head and neck, and the patient carried carefully upon a stretcher, there is a probability of adding to the bruising and laceration of the cord. Unfortunately, such care is not always granted the patient. The author has seen a young man carried from the foot-ball field writhing in agony from a fracture of the cervical vertebræ, without even a hand to steady his head.

Gentle attempts at reduction may be tried, using traction and beginning as early as possible. If necessary an anesthetic may be used, but in some cases of cervical fracture the patient may already be stertorous,

unconscious and almost pulseless. In some instances, too, attempts at reduction of a fracture-dislocation in the cervical region may aggravate the displacement and injury of the cord, producing immediate death. If reduction has been accomplished in the dorsal or lumbar region a plaster or paper jacket may be applied, perhaps with extension and counter-extension to the head and legs. During and after the application of the jacket the patient should be critically watched. Its application is facilitated by placing the patient upon an ordinary dining-room table and with-drawing one section from beneath the site of the injury; or the patient may be placed upon two tables which are slowly separated, giving space enough between them to apply the jacket. If the fracture is reduced spontaneously or by manipulation and the symptoms persist it may indicate that the cord has been injured; still operation may be postponed for a time, as regeneration may not manifest itself for a month. As before advised, in such delayed cases the bladder and bowels must be watched and cared for, bed-sores anticipated, and the muscular tone of the paralyzed limbs or of the body maintained by electricity, massage, Swedish movement, etc.



Fig. 491.

Fracture of Body and Left Transverse Process of Ninth Dorsal Vertebra; Bullet and Fragments of Bone Shown to Left.—Army Medical Museum, Washington.

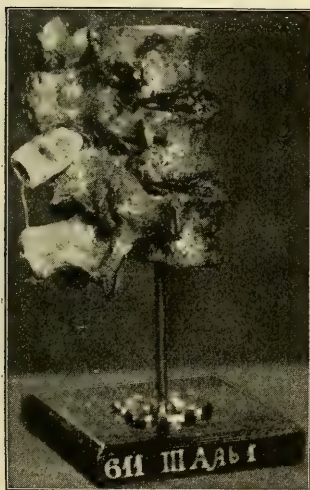


Fig. 492.

Fractured Spinous Process with Bullet Wired in Situ—Army Medical Museum, Washington.

It is the rule not to operate in cases where the reflexes are such as to indicate total or complete transverse destruction of the cord; i. e., a continued absence of the reflexes, notably the patellar, bilaterally. And yet, rare instances of successful operations have been reported in these cases. This rule is based upon the belief that the injury is sufficiently extensive to prevent regeneration. Unilateral impairment of the reflexes is rather an indication for operation. Probably a reasonably good rule would be to operate just as early as possible when the above symptoms exist in a lesser degree than that which represents complete destruction of the cord, being influenced, of course, by the site of the lesion and remembering that but little is expected of operations above the seventh dorsal vertebra. In a



series of 270 spinal fractures collated by Gurlt which were not operated eighty per cent., or 217, died, and those cases that did not die cannot all be regarded as recoveries, as some of them suffered from the usual distressing cord symptoms. Thorburn collated a series of operated cases in which the mortality rate was fifty-seven per cent.—not what could be wished, but still a decided gain over the results from the expectant plan. Since these compiled reports there has been considerable improvement in technique and the results should be better.

For the technique of the operation, see Laminectomy.

**Complications and Sequelæ of Spinal Injuries.**—**URINARY DISTURBANCE.** This is one of the most troublesome and at times may prove indirectly one of the most serious concomitants of spinal injuries. As previously stated, there is first retention of urine. This should be anticipated in all traumatism of the spine and catheterism be resorted to when demanded. Subsequently the urine escapes involuntarily—generally a passive enuresis—and even with this condition there may be a large quantity retained and decomposing, and giving its characteristic ammoniacal odor and alkaline reaction. It becomes cloudy, offensive and phosphatic, from the cystic atony and resulting cystitis, which is likely to traverse the ureters, and pyelitis and pyelonephritis and the dreaded “surgical kidney” result.

Associated with this there is sometimes colonic paresis or fecal incontinence, which adds much to the patient's distress and the attendant's labors.

*Treatment.* Catheterism is, of course, necessary and demands the most scrupulous care on the part of the attendant. If the patient is a female, glass catheters which can be thoroughly sterilized by boiling in a soda solution are preferable. It is just as important, too, to cleanse the meatus and the surrounding area each time before the introduction of the catheter. Male catheters are much more difficult to cleanse. They should be washed with soap and water each time after using, a stream of water passed through, and then kept in a mercuric or carbolic solution and rinsed in plain boiled water or soda solution before introduction.

Cystitis and nephritis may occur in such cases without the use of the catheter, but are far less likely to if the catheter and urethral orifice are kept clean. Boric acid in five grain doses, or salol in similar doses, is sometimes administered three or four times a day for the purpose of keeping the urine in as healthy condition as possible. Beyond this little can be done for such deplorable conditions, although some recommend laminectomy, which, in carefully selected cases, is probably justifiable.

**BED-SORES.** Confinement in bed after spinal traumatism is just as likely to produce the ordinary bed-sores from pressure as any other affection which compels the patient to remain in bed. But added to this there is a particular liability to their occurrence after spinal injuries because of the trophic disturbance following section or partial section of the cord, cord-pressure from a clot or bone-splinters, myelitis, etc. The difficulty of keeping the patient clean, on account of urinary and perhaps fecal incontinence, is another causative factor.

The ordinary bed-sores are largely the result of pressure, as shown by the fact that they occur only over bony projections, e. g., the trochanters, the coccyx, the sacrum, etc.



The neuropathic bed-sore may not only appear at such projecting points but also upon areas where no pressure is exerted. There is rapid destruction of circumscribed spots, sometimes requiring only forty-eight hours or less. They appear on the side opposite the wound when there has been unilateral or hemi-section of the cord. The sloughing may be moderate or extensive and septicemia is a possible sequence.

*Treatment.* Symptomatically, the snake poisons, arsenicum, rhus, etc., are indicated. The essential treatment, however, is prophylaxis. This does not differ from the care of ordinary bed-sores, except that in the case of spinal injury they may be anticipated, the patient subjected to frequent examinations, change of position, with the use of perforated cushions, pads, etc., to change the point of pressure. The sheets should be kept smooth and free from bread crumbs, and the skin bathed and kept clean. This is often a difficult task in cases of fecal and urinary incontinence. This subject is considered further in the chapter on Bed-Sores.

**SPINAL HEMORRHAGE.** When the hemorrhage is within the cord it is known as hemato-myelia; when membranous it is called hematorrhachis. In the latter the hemorrhage may be either extra-dural, sub-dural or sub-arachnoid. It is claimed by some that mild cases of hemorrhage within the cord have occurred without visible evidence of injury to its coverings or the spine, and hence the contention regarding the word concussion. Compressive hemorrhages are thought to occur most frequently in the lower cervical and upper dorsal regions and may be attended with varying degrees of anesthesia, contraction of the pupil, paralysis, retention of urine, priapism, etc. Anesthesia has also been found upon the inner surface of the arms. Such symptoms are likely to be sudden in their onset and may be transient unless the hemorrhage has been of a sufficient degree to produce atrophic paralysis. Tonic or spastic symptoms of the lower extremities sometimes persist after the subsidence of the other symptoms.

Extra- or sub-dural hemorrhage occurs suddenly and may be suspected when the disturbed sensory and motor areas increase, as the blood finds its way along the spinal canal.

*Treatment.* This is largely expectant, keeping the patient quiet, in the recumbent position, and administering a light and non-stimulating diet.

Absorption of the clot is to be hoped for and to aid in this the author knows of no remedy that renders more service than sulphur; the 3x and 30x are prescribed in these cases. It would seem that some, or perhaps all of the varieties of hematorrhachis might sometimes become amenable to surgical treatment, but so far little has been done in this direction.

**COCYGO-DYNIA.** Pain in the coccyx not infrequently follows contusion or fractures of the coccyx. Falls upon the ice and parturition are probably the most frequent causes. Long continued sitting, especially in a low chair which is tilted back somewhat, has also been known to produce it. It is often distressing, making it impossible to walk, stoop or sit comfortably.

*Treatment.* This consists of the administration of the indicated remedy, which will usually be bryonia, gelsemium, rhus, arnica or actea spicata, and if these fail and the discomfort is sufficient to justify it, extirpation should be resorted to. Para-coccygeal section is not very successful.

**Compression of the Spinal Cord.**—As already seen, this is frequently associated with other lesions, as tumors, spinal fractures and

dislocations, foreign bodies, aortic aneurism, hemorrhage, caries, etc. It is both acute and chronic, according to the cause. It would be but a repetition to enumerate the symptoms, as they accompany the lesions already described and the treatment is the treatment of compression.

**Acute Traumatic Meningitis.**—This results from various forms of injuries and is generally associated with inflammation of the dura mater (pachymeningitis) or of the pia or arachnoid (leptomeningitis). Myelitis is often an accompaniment. Pus often accumulates and may be either extra- or sub-dural, and lying thus may prevent the dura from adhering to the bone or cord.

The symptoms may be gradual or abrupt in their onset and usually consist of a chill or chilliness, vomiting, rise in temperature with the corresponding changes in pulse and respiration. In severe cases there is delirium, or possibly coma. The backache and shooting and burning pains are extreme. When the cord becomes affected the reflexes which were primarily exaggerated soon disappear. When the process extends as high as the cervical region, there is paralysis of the arms, body and lower limbs. There is cutaneous hyperesthesia, muscular spasms and possibly opisthotonos. Death from respiratory paralysis, bed-sores, exhaustion, cystitis and nephritis, is not uncommon.

The treatment, in the main, is prophylaxis. During and subsequent to the attack the same general attention must be directed to the care of the bladder, bowels, skin and bed-sores as has previously been advised. Ice-bags to the spine during the acute period are employed. Later the contractures of the limbs should be treated—or better, prevented—by splints, weights and passive motion. Electricity is also used. As internal medicines belladonna, gelsemium, arsenicum, cicuta, strychnia, etc., may be employed.

**Acute Traumatic Myelitis.**—Open or closed subcutaneous traumatism, strains and excessive muscular exercise are the causes. Suppuration seldom occurs except where there is an open wound through which the cord becomes infected.

**SYMPTOMS.** Girdle pains, either transient or persistent, together with chill and moderate fever, headache and rarely muscular spasms and varying degrees of sensory and motor paralysis. Pain and paresthesia disappear as the function of the cord is destroyed, and hence applications, dressings or hot water-bags may damage the structures to which they are applied without the patient making any complaint. A chronic form may exist, the manifestations of which appear gradually. The remaining symptoms as well as the treatment are practically the same as just outlined in traumatic meningitis. These affections are not infrequently combined as meningo-myelitis.

## SECTION XVIII.

# DISEASES AND INJURIES OF THE NERVES.

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## CHAPTER I.

### DISEASES OF THE NERVES.

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**Painful Nerves.**—(“Neuralgia”). To this affection the much-abused term neuralgia is applied and has been allowed an extremely loose and careless application. As here considered the subject of painful nerves will have reference only to lesions of the nerve per se, and not to the mere transmission of pain through the nerve from some associated lesion.

The varieties of neuralgia which most frequently assume surgical phrases are the trifacial (neuralgia of the fifth pair, *tic douloureux*, *prosopalgia*, *epileptiform neuralgia*, etc.), sciatic, the so-termed *metatarsalgia* (Morton’s neuralgia), *coccyodynia* and the painful stumps and *cicatrices*. Other varieties, as well as a prolonged discussion of some of those already mentioned, belong to the domain of general medicine.

**SYMPTOMS.** Paroxysmal pain of an intense, shooting character is generally complained of along the course of the nerve-trunk or over its distribution. It is quite likely to be worse at night. There may be no pain at all between the paroxysms or it may be of a dull, boring ache, with sensitiveness to pressure, motion and atmospheric changes. It is often periodical, such periodicity having given rise to the supposition that it possesses a malarial element—a theory which has undoubtedly been overworked. The author has seen it recur with marked regularity in an ancient thigh stump. The affected nerve is quite likely to be sensitive at its point of exit through the bone or fascia, or even at its level of separation from the spinal cord. The pain from these affected nerves is excruciating, often driving the patient to seek relief in the morphia habit or suicide. Probably the most intractable variety is that affecting the fifth cranial nerve and its divisions. The patient often dreads to speak, swallow or masticate. The pain may follow the ramifications of the nerve till the whole face and even the mucous membrane of nose and mouth are involved. In the supra-orbital variety, if not too sensitive, the constant application of the fingers may wear away, more or less completely, the hair of the eyebrows. As opposed to this, the author has seen instances of unilateral sciatic pain attended by a very marked growth of hair over the painful area. The skin supplied by the affected nerve is often hyperesthetic, making deep pressure more bearable than superficial.

**DIAGNOSIS.** This usually offers little difficulty. The absence of any visible local lesion—with the possible exception of congestive neuralgia



and herpes, which are, in any case, the accompaniments of neuritis instead of a simple painful nerve—the freedom from inflammatory symptoms, the intensity and paroxysmal nature of the pain, its tendency to recurrence, sensitiveness at points of exit, and the patient's willingness to submit to almost any operative treatment, are all diagnostic features. Extreme caution and fine discrimination are sometimes necessary to exclude the conditions wherein the suffering is due to nerve-pressure from tumors, foreign bodies, osteitis, cord and brain lesions and inflammatory exudate. The surgeon will not forget that it is possible that the site of the painful nerve may be at a joint, without the existence of arthritis or peri-arthritis.

**TREATMENT.** It is presumed that the resources of general medicine will have been exhausted before the surgeon is called upon, or operative measures are contemplated. The surgical measures consist, in the main, of removal of the painful nerve (neurectomy) and nerve-stretching (neurectasy). Section of the nerve (neurotomy) is not now regarded as efficacious because of the readiness with which the nerve ends re-unite. These operations are described under Injuries of Nerves.

**Metatarsalgia.**—This consists of pain in the metatarso-phalangeal joint of the fourth toe. Some believe it to be due to partial luxation and pressure upon the external plantar nerve. In some cases at least this is probably correct, as occasionally its sudden onset is relieved promptly by certain movements of the toes. It is presumed that such movements reduce the dislocation. Others believe it to be neuritis.

Narrow shoes, and possibly incipient flat-foot, are the causes. It is often severe, sometimes compelling the patient to come to a standstill on the street and remove the shoe. It may radiate up the leg and is aggravated by lateral pressure.

**TREATMENT.** The treatment is the removal of the lateral pressure, by wearing wide shoes. This sometimes affords relief. In severe cases it may be necessary to remove the head of the fourth metatarsal bone. Amputation of the toe has also been resorted to. The excision of the head of the bone has frequently been successful, but like painful affections of the nerves elsewhere a complete cure sometimes seems impossible.

**Neurotic Torticollis.**—Wry-neck is sometimes due to spasm of the spinal accessory or upper cervical nerves. The varieties of torticollis due to congenital muscular shortening, myositis, adenitis, spinal caries, abscesses, tumors old cicatrices, etc., must be excluded. The general description, symptoms, and diagnosis will be found in the section on orthopedics. The muscular spasm may be clonic or tonic. Either variety, while not usually very painful, is quite distressing. The clonic form with its jerking, rotary motion is both annoying and wearisome.

**TREATMENT.** After the exhibition of belladonna, ignatia, actea racemosa, cuprum, strychnia, gelsemium, etc., electricity, and massage, extension of the neck by suspension from the tripod or jury-mast may be tried. These measures—perhaps coupled with partial or complete section of the contracting muscles—failing, neurectomy of the spinal accessory nerve is advised. This is usually insufficient if muscles other than the sterno-cleido-mastoid and trapezius are involved, and the upper cervical, which contract the deep rotators of the head, are sometimes divided. The patient's neck should be made as prominent as possible—without

interfering with the breathing—by having the head thrown somewhat backward, the face turned away from the operator and the shoulders resting upon a pillow. The spinal accessory nerve is exposed by an incision beginning at the mastoid process and carried downward three or four inches in length along the anterior border of the sterno-mastoid muscle. In the upper angle of the wound the inferior border of the parotid gland will be exposed. By blunt and careful dissection, with the retraction of muscle and fascia outward and backward, the transverse process of the atlas is reached. The posterior belly of the digastric muscle, running downward and forward, lies in front of the spinal accessory nerve. It emerges from the jugular foramen, passes out from under the inferior edge of the digastric muscle, makes its way across the transverse process of the atlas and penetrates the belly of the sterno-mastoid muscle, from whence it passes obliquely across the occipital triangle to be lost in the trapezius. The nerve is picked up by a blunt hook or forcep and a piece perhaps half an inch in length is removed. It may occasionally be found necessary to perform neurectomy of the posterior branches of one or more of the upper cervicals. They are exposed by a free transverse incision which extends from the posterior median line and divides the trapezius muscle a little below the lobe of the ear. The muscle is raised and the great occipital nerve exposed as it emerges from the complexus muscle to penetrate the trapezius. The former muscle

is divided transversely and the nerve traced through the muscle and cautiously exposed downward to its origin from the posterior division of the second cervical nerve. The nerve is then severed and a piece excised behind the great occipital origin. The posterior division of the first cervical nerve, or sub-occipital, as it is called, lies in the sub-occipital triangle, to which it may be traced by its course below the inferior oblique. This nerve is then severed and a portion removed. Under the complexus muscle, perhaps an inch below the great occipital nerve, the external branch of the posterior division of the third cervical nerve is found and is divided close to the main nerve bifurcation.

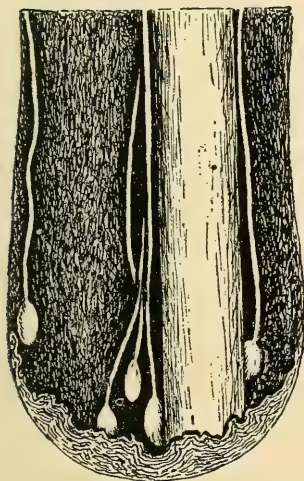


Fig. 493.

Bulbous Nerves in a Stump.

variety, e. g., the exceedingly painful affection so long called “sub-cutaneous tubercle,” and which was believed to be a true nerve tumor, has been shown to be a small fibroid, pressing upon a sensory nerve. They are generally single, but in occasional instances they have been found multiple. A tumor is not regarded as a neuroma unless its histological structure is found to be nerve tissue, to a considerable extent. The post-traumatic tumor or bulbous nerves found in stumps after amputation probably offer the most frequent example of what appear to be true neuromata. (Fig. 493.)

**Neuromata.**—(Tumors of Nerves). Tumors of nerves are quite infrequent. Many small growths formerly regarded as neuromata are now known to belong to some other



Among the varieties of growths connected with, lying on, or attached to nerves are sarcoma, carcinoma, glioma and myxoma, which are rarely found. Cysts of the nerves are also found infrequently and are believed by some to be the remains of growths previously solid which have undergone cystic changes.

**SYMPTOMS.** The symptoms are variable according to the function of the nerves and whether the pressure is mild or severe. If the growth occurs within the sheath of the nerve or even when lying outside it, and is pressed upon by such unyielding structures as fasciæ, the distress is likely to be extreme. When the growth is attached to the nerve or its sheath it will have lateral mobility, but will be immobile in a direction parallel with the nerve trunk. From a tumor so situated pain may be referred to the area supplied by the terminal fibres. In more than one instance convulsions or epileptiform seizures have been produced by such nerve-involvement. The aura has been described as starting from a painful finger stump, the re-amputation of which abolished all symptoms. In spite of all this it is occasionally possible for a nerve tumor to exist without producing any symptoms, but this is the exception. If it is deeply situated it may be impossible to discover it by palpation, but trophic changes in skin and muscles, or peripheral paralysis, may call attention to it. If superficial, as, for instance, the painful sub-cutaneous tubercle before referred to, it will be readily felt by the finger and is exquisitely sensitive to the touch.

**TREATMENT.** If there is no reason to suspect malignancy, and usually there is not, and the growth is painless and provokes no paretic or trophic symptoms, it should not be molested. On the other hand, if such symptoms are present or pain is severe the tumor must be excised. If it is not a growth of the nerve itself but merely attached to the sheath or making pressure against it it should be dissected out carefully without injuring the nerve. If the nerve-sheath is opened cautiously it will be found possible, in some instances, to enucleate the tumor and preserve the nerve-trunk. When the nerve is involved a portion of it may be excised, the ends stretched and united with sheep-gut. (See Neurectomy and Neurorraphy). If coaptation is impossible it is advisable to introduce two or more long sheep-gut stitches and hold the ends opposite each other, after which union and function may be expected. Neurectomy or excision of a portion of the proximal side of the nerve may be resorted to when the tumors are multiple, as attempts at extirpation of the growths in such cases are not satisfactory.

**Neuritis.**—**DESCRIPTION.** Neuritis is the term applied to inflammation of the nerves. Multiple or diffused neuritis or polyneuritis, which designates the simultaneous involvement of several nerves and is so often attended with pain, ataxic and paretic symptoms and muscular impairment, does not come within the domain of surgery. Beri-beri belongs to this class, but differs in geographical situation and etiology. It is endemic and believed by some to be produced by a micro-organism; but others contend that it is caused by rice, and still others by a toxine from decomposing fish. Isolated, localized or single neuritis is the variety possessing the most surgical possibilities. It may vary much in intensity and hence is divided into the acute, sub-acute and chronic forms. The inflammation sometimes extends along the nerve towards the periphery



(descending neuritis) but more frequently towards the vertex (ascending neuritis). It attacks the peri-neurium, (peri-neuritis) the inter-neural connective tissue, constituting interstitial neuritis, or the nerve fibres themselves (parenchymatous neuritis).

**CAUSES.** Traumatism, infection, exposure to cold and wet, gout, syphilis and rheumatism are among the common causes. Neuritis may be secondary to an inflammation or ulceration in proximity to the nerve. Arthritis, necrosis and adjacent malignant growths furnish examples of this kind.

**SYMPTOMS.** Pain is the chief symptom. It is likely to be worse at night, perhaps remittent, and is referred along the course of the nerve. It is likely to be aggravated by atmospheric changes, touch or motion. The symptoms are variable according to the physiological nature of the nerve, the extent of involvement and whether the inflammation be mild, severe, acute or chronic. If a motor nerve is attacked, there are likely to be muscular twitching, sensitiveness, weakness and perhaps atrophy of the muscles to which the affected nerve is distributed. When a sensory nerve is involved there is peripheral numbness, tingling, formication and possibly hyperesthesia and anesthesia. Pain may be referred to the corresponding nerve or nerves upon the opposite side of the body or limb, apparently without the involvement of the spinal cord. It will, therefore, be seen that a muscular reflex may possibly be excited even when a sensory nerve is the seat of inflammation. Constitutional symptoms are rather rare, though fever, chills and headache have been noted. The hard, cord-like feel may be recognized by the palpating fingers when the affected nerve is superficial, and the local temperature may be elevated. The evidences of trophic changes accompanying neuritis are thickening and glossiness of the skin, herpetic eruption or ulceration, diminished or increased perspiration, unguinal malnutrition, atrophy and contracture of muscles, effusion and fixation of joints, and in some cases painless felons and destruction of the osseous structures of the fingers. Neuritis, even if not a causative factor, is an accompaniment of Raynaud's disease, Morvan's disease, diabetic gangrene and leprosy.

**DIAGNOSIS.** Many cases of neuritis are diagnosed painful nerves. The latter is an afebrile affection, both constitutionally and locally, and lacks the trophic changes and the cord-like feel of the swollen and inflamed superficial nerve. Neuritis may be differentiated from osteitis, periostitis and rheumatism by the fact that the pain and tenderness of neuritis is more or less confined to a line corresponding to the course of the nerve. In multiple neuritis this would not be the case.

**TREATMENT.** The internal medicines most frequently indicated are belladonna, spigelia, china, ignatia, actea racemosa, arsenicum, rhus tox., pulsatilla, bryonia, etc. The general treatment will vary according to the cause. If due to any bodily taint, like syphilis, gout, etc., the patient will receive the appropriate constitutional treatment. If secondary to a wound or ulcer the most rigorous antiseptic measures should be employed till the wound has been rendered thoroughly aseptic. Hot fomentations, and occasionally ice, may be applied, and the limb elevated. The affected limb should be put at rest upon a carefully padded splint, and bandaged. It is well to have a generous layer of cotton or wool between the bandage and the sensitive skin. Of course the tendency is to fly to morphia and

cocaine, which are injected beside the nerve. Both afford temporary relief but are dangerous drugs, the patient being likely to become addicted to either.

It is important to give the atrophied muscles attention in order to keep them in as good a state of nutrition as possible till the inflamed nerve can recover its function. This may be done after the acute stage by gentle massage, hot and cold applications, and galvanism continued for weeks. The fact that a certain degree of peripheral anesthesia may exist and applications sufficiently hot or cold to destroy tissues may evoke no complaint from the patient, should not be lost sight of.

As a last resort nerve stretching is employed, but, although it sometimes yields good results, is not to be relied upon too strongly.

**Spasm of the Facial Nerve.**—**ETIOLOGY.** This rather frequent affection, sometimes called “mimic tic,” “mimic spasm,” and “histrionic spasm,” generally occurs without an assignable cause. In occasional instances it has been attributed to mental shocks, falls, anemia, etc. Tumors and organic disease of the brain may clearly be causative.

**SYMPTOMS.** The symptoms are unmistakable. Clonic spasms of certain muscles of the face are quite familiar. The orbicular muscles are probably affected more frequently than any others. The twitchings may occur with great rapidity, and may involve muscles of the face, tongue, neck, or arm, it being possible for the spasm to excite secondary twitching in muscles supplied by other nerves. It is usually painless, and, unless associated with some other lesion possessing an element of gravity, is not serious, though sometimes extremely distressing.

**TREATMENT.** Like that of other affections of the nerves, the treatment is often inefficacious. Among the medicines which are usually employed are belladonna, *actea racemosa*, *nux vomica*, *gelsemium*, *ignatia*, *zincum*, *strychnia*, etc.

The teeth and eyes should be carefully examined, as abnormalities of either may be the primary cause of the spasm. The correction of visual or refractive defects has not infrequently proven curative. In some cases electricity is helpful.

Some improvement has followed nerve-stretching, but it is usually temporary. For this procedure the nerve is exposed as it emerges from the stylo-mastoid foramen. Neurectomy, while more efficacious, is attended with such a degree of disfigurement that it is generally objected to. The nerve is reached by either the post or anterior auricular incision. The former is generally preferred because so much of the scar is hidden. It is begun somewhat vertically, is two and a half inches in length, with an angle the apex of which is directed toward the apex of the mastoid process. The parotid gland is pushed forward and the nerve will be found lying between this and the sterno-mastoid muscle. It lies at a depth of an inch, sometimes more, and rests upon the facial covering of the muscles lying anterior to the vertebræ. It crosses the narrow groove between the ramus of the jaw and the mastoid process, lying about one-half inch in front of the latter.

A head-mirror, electric light and a small electrode with a weak current aid in securing the nerve.

## CHAPTER II.

### TRAUMATISM OF NERVES.

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**Varieties.**—Like the other tissues of the body, the nerves are not uncommonly subjected to the various forms of traumatism, and although these occur more frequently in the upper extremity they are likely to be found upon any portion of the body or limbs. Contusion, compression, dislocation, laceration and incision are of sufficiently frequent occurrence to demand attention.

**Contusion.**—The causes are essentially falls and blows. The most frequent examples are blows upon the brachial or cervical plexus, and contusion of the circumflex from falls upon the shoulder. Of course fragments of bone from fractures are often the cause of contusions to adjacent nerves, but as such a cause persists for some time it might almost be regarded as compression.

**SYMPTOMS.** A sensation as of pins and needles pricking the tissues supplied by the distributions of the injured nerve is complained of. It may be attended with a sense of numbness and heaviness. There is loss of function, muscular twitching, 'anesthesia and sometimes painful convulsive jerking of the muscle. The trophic changes manifest themselves later in atrophied muscles and paresis. These may be perpetuated by cicatrix at the site of the contusion, or neuritis may have supervened.

**TREATMENT.** Arnica, rhus tox., hypericum, bryonia, belladonna and other remedies will be found useful. Necessarily the treatment will vary according to the cause. If the cause is continuous, such as a post-traumatic cicatrix, the nerve must be exposed and the scar removed. (See Neurectomy.)

The majority of the contusions are temporary in their manifestations and when they do not subside the treatment is practically that of neuritis, before described, because this may be a sequence to the trauma.

**Compression.**—Nerve compression is frequently caused by tumors, fractured ends of bones, scars, inflammatory exudate, callus, etc. Other common examples are crutch-pressure in the axilla, the pressure from the back of a chair when the arm is allowed to hang over it during sleep, and the pressure from the edge of a chair or bed upon the sciatic nerve when sitting too long.

Slow growths, such as exotoses, may produce gradual compression. From fracture of the clavicle the brachial plexus may be compressed, as may the musculo-spiral nerve from fracture of the humerus, and the sciatic from fractures of the pelvis. When peripheral muscular paresis manifests itself at the time of the fracture it is due to contusion or compression. If it is not observed until some time after the injury, then the inflammatory exudate or callus is impinging upon the nerve.

**SYMPTOMS.** The symptoms are similar to those of contusion and vary with the cause. If the compression is gradual, as from the slow



growth of a tumor, the onset of the symptoms will be gradual. If it occurs with intensity and rapidity the paresis and paresthesiæ present themselves immediately.

**TREATMENT.** This consists of the removal of the cause. The temporary cause is generally accompanied with temporary symptoms. If there is a history of trauma, scar-compression may be suspected and the nerve exposed and liberated. If a fracture has preceded the onset of the symptoms the nerve is probably entangled in the callus, or inflammatory exudate. The nerve must be exposed both upon the distal and proximal side of the ancient traumatic site and carefully liberated. Neurectomy and neurorrhaphy may be necessary, in which case it will be found a decided advantage to have both ends of the nerve already exposed. It may be necessary to chisel or gouge away some of the callus.

**Dislocation.**—When the fibrous bands which restrain the ulnar nerve in its groove behind the epicondyle are ruptured by a blow or violent wrenching, the nerve then slips from its groove when the elbow is flexed.

**DIAGNOSIS.** While the elbow is being flexed the cord-like feel of the movable nerve may be demonstrated. Pressure from the palpating fingers produces the characteristic tingling sensation.

**TREATMENT.** The treatment consists of absolute rest, with the arm quite straight and carefully padded, splinted and bandaged, so as to hold the nerve in place till the torn fibres can heal. This should be persisted in for some time, and if unavailing the nerve should be exposed and sutured in its normal position by means of sheep-gut.

**Lacerated and Incised Wounds.**—The causes are the same as those producing lacerated and incised wounds of other structures and are, therefore, as familiar as they are varied.

**SYMPTOMS.** If the nerve is completely severed there will be loss of muscular power and tactile sense. Pain may or may not be intense, but numbness, tingling and burning are common symptoms. When the division of the nerve is incomplete neuritis and hyperesthesia may exist. With the infliction of the injury consciousness may be lost and shock is sometimes quite marked.

Occasionally a nerve laceration upon one side may be followed by paralysis upon the other, such being reflex and manifesting itself promptly upon the receipt of the injury, or it may develop slowly. As in other nerve injuries trophic changes appear after a time. The area receiving the distributions of the injured nerve shows muscular atrophy and the glossiness of the skin described with neuritis. There may be a decrease in the perspiration, or it may be increased, possessing a foul odor. Sub-acute inflammation and fixation of the joints and wasting are among some of the later indications of nerve degeneration. A grave error in diagnosis may be committed unless the clinician studies the associated symptoms in order to assure himself that he is not dealing with a simple arthritis. The nails are often curved and marked with furrows and ridges, and perhaps partially surrounded with herpetic eruption or ulceration. Peripheral gangrene also supervenes at times.

**DIAGNOSIS.** The sensory function should be carefully studied. An esthesiometer, or an ordinary pair of compasses and a tape measure or rule of any kind, will be found useful. The patient is not allowed to

watch the proceedings, but should be asked to tell whether the compass points, which are placed simultaneously upon the skin, give him the sensation of one or two points. If they feel like one then they should be separated till both points are felt and then the distance between them measured and compared with the sound limb. Frequent comparisons should be made. The skin over a certain area may be anesthetic, while the subcutaneous sensation may still exist, hence will be seen the necessity of touching the skin lightly. Thermal tests, with hot and cold water, should be tried. Electrical tests will also be employed, and both anesthesia and paresthesia will be noted.

Loss of motion is readily demonstrated in certain groups of muscles by comparing their power to their fellows on the sound side. The dynamometer, grasped in the hand, is useful in determining the power of the muscles of the forearm.

**PROGNOSIS.** In watching the remote effects of such nerve injuries it will generally be observed that sensation will return before motion. While the prognosis should be somewhat guarded it will be based upon the extent of the injury, the degree of motor and sensory impairment and the length of time that has elapsed since the injury.

**TREATMENT.** When a nerve has been severed, in either an accidental or operative wound, it should be immediately united. If there is only partial division of the nerve the treatment will be that of neuritis. Secondary suture of nerves, severed by ancient traumatism, is not as satisfactory as primary suture; hence the advisability of a correct appreciation of the nature of the injury and the institution of reparative measures before nerve degeneration has occurred. The wound in general will be treated according to surgical principles, thoroughly cleansed, cleared of shreds and clots, all bleeding checked and neurorrhaphy performed.

### CHAPTER III.

## TRAUMATISM OF SPECIAL NERVES.

**Ulnar Nerve.**—This nerve is readily injured at the internal condyle or wrist. Its section results in paralysis of the following muscles: One-half of the flexor brevis pollicis, the abductor pollicis, the interossei, the two ulnar lumbricales, the hypothenar group entire, half of the flexor profundus, and the flexor carpi ulnaris. This paralysis, with its unequal muscular tension and subsequent atrophy, produces marked changes in the

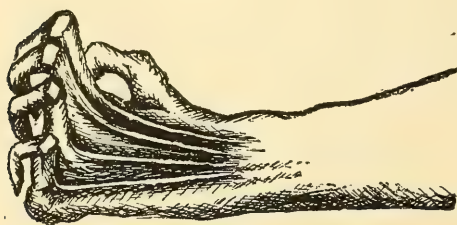


Fig. 494.  
Contractured extensors after division of  
ulnar nerve.

hand. The thenar and hypothenar eminences become flattened and wasted, the first phalanges are in hyper-extension, even to posterior dislocation, while the last two are semi-flexed, giving the hand an unsightly, claw-like appearance. (Fig. 494). Although the area of anesthesia varies somewhat after division of the ulnar nerve, it will generally be found to affect the

anterior and posterior surface on the ulnar side of the hand. The entire little finger and the outer half of the ring finger are more or less completely devoid of sensation. (Figs. 495 and 496.)

**Median Nerve.**—On the flexor surface of the wrist this nerve is not infrequently severed. It may be divided higher in the forearm or in the arm, but this is less likely to occur. The paralysis varies with the location of the injury. When it occurs at the wrist the power of the thumb is lost and small objects cannot be grasped or held with any degree of satisfaction, as the thumb cannot be brought into apposition with the little finger and only imperfectly, if at all, with the others. When the nerve is divided in the arm the muscles of the forearm will be involved. The entire group of flexors and pronators are paralyzed, excepting those two already seen to be paralyzed by the division of the ulnar nerve, namely, the flexor carpi ulnaris and the ulnar half of the flexor profundus. The paralysis extends to all the muscles of the thumb save the adductor and half of the flexor brevis. Flexion of the wrist, supination and pronation are markedly interfered

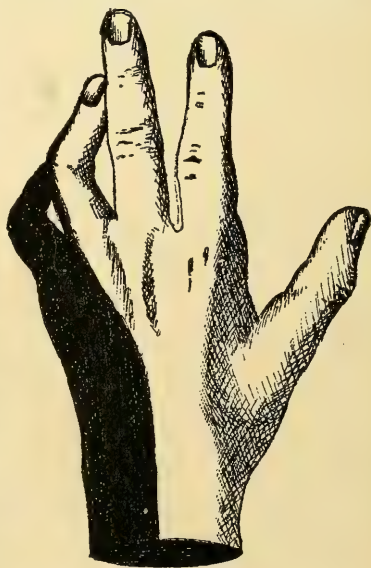


Fig. 495.  
Posterior area of anesthesia after sec-  
tion of ulnar nerve.



with. The thumb assumes an extended position rather close to the index finger. The ring and little finger give evidence of some loss of power in the first and second phalanges. If the injury is somewhat ancient the atrophy of the muscles of the forearm becomes apparent. The wrist is likely to become somewhat extended toward the ulnar side, and the head of the metacarpal bone of the thumb is noticeably prominent—the accompaniment of atrophy of the ball of the thumb.

Should the injury occur at or near the wrist the paralysis will naturally be less extensive but the thumb will still present the unmistakable physical signs. Anesthesia can be demonstrated over the dorsal surface of the first and second and half of the third finger. The palmar surface of the thumb and radial half of the palm, the index, middle and radial half of the ring finger are anesthetic. It will not be assumed that there can be no deviation from this, or that the anesthetic and esthetic areas begin and end abruptly. There is quite likely to be a more or less gradual shading off from anesthesia to dyesthesia and esthesia. (Fig. 497.)

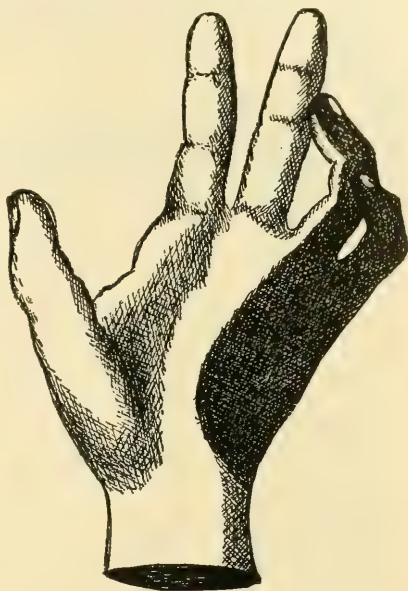


Fig. 496.

Anterior area of anesthesia after section of ulnar nerve.

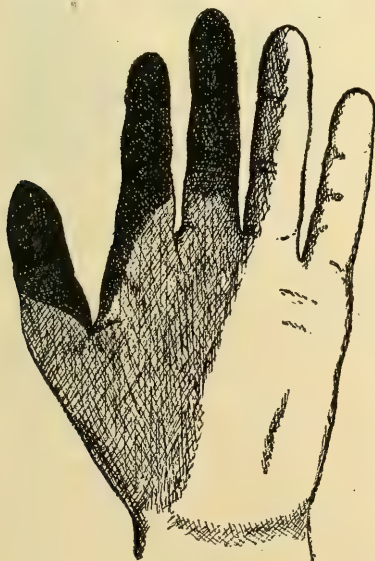


Fig. 497.

Anesthetic area after section of median nerve, shading off to normal sensation.

**Radial Nerve.**—When this nerve is severed the paralysis will not be extensive, since it supplies sensation only to the skin over the first and second metacarpal bones and the dorsum of the thumb. Its section occurs occasionally when wounds are inflicted just above the junction of the base of the thumb and the wrist, as here the nerve sweeps around from the flexor to the dorsal surface of the wrist.

**Musculo-Spiral Nerve.**—Fractures of the humerus not infrequently cause this nerve to be injured. It is occasionally involved in deep injuries, such as stabs or gunshot wounds of the arms. The characteristic sign in this injury is wrist-drop. (Fig. 498). This is produced also by lead-poisoning, the drunkard's sleep (with the arm under him or over the back or arm of a chair), and the author has seen wrist-drop occur as a result of crutch-pressure.

Supination and extension are interfered with, the latter being most marked. The supinators are paralyzed but the action of the biceps is

that of a supinator and flexor. Extension of both wrist and fingers, and sometimes the elbow, is destroyed. Naturally the extensor muscles atrophy. Sensation is lost on the outside of the arm from the elbow to the

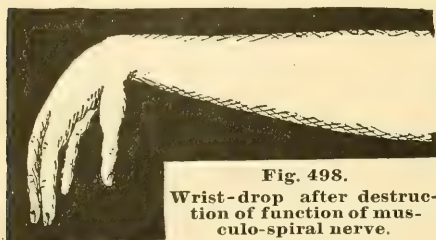


Fig. 498.  
Wrist-drop after destruction of function of musculo-spiral nerve.

deltoid muscle. The extent of this area is about one-quarter of the circumference of the arm, including the dorsal surface of the upper two-thirds of the forearm, on the radial side, and a portion of the lower third. It includes also the dorsal surface of the middle and index finger and thumb.

In this, as in other nerves just studied, the level at which the injury is received influences the extent of both sensory and motor paralysis. Of course there will be a commingling of the signs and symptoms when two or even more of the brachial nerves are severed coincidentally.

**External Popliteal (Peroneal) Nerve.**—This is sometimes severed both in accidental and operative wounds in proximity to the external ham-string tendons. The injury is somewhat analogous to the preceding in that it is characterized by foot-drop, in consequence of paralysis of the anterior muscles of the leg—the function of which is to raise the foot—and hence the great toe brushes the floor with each step. (Fig. 499.)

**Great Sciatic Nerve.**—Owing to its being situated so deeply in the thigh, this nerve escapes injury except in occasional instances of gunshot or other deep or penetrating wounds. When divided all the muscles below the knee are paralyzed, but not those of the thigh, and hence in walking the leg is thrown forward by the muscles of the hip. Sensation is impaired on the outer surface of the leg and on the foot.

**Anterior Crural Nerve.**—Section of this nerve is sometimes attended with inability to walk, and when walking is possible it is performed with difficulty, as flexion of the hip and thigh is interfered with. The paralysis involves the muscles of the anterior portion of the thigh. Sensation is more or less impaired over the inner surface of the thigh and leg.

The treatment of injured nerves will be found under Injuries of Nerves and Neurorrhaphy.



Fig. 499.

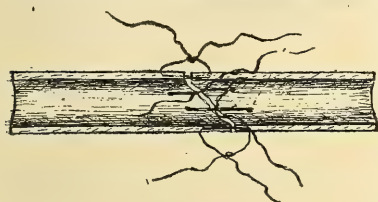
Foot-drop after destruction of function of external popliteal nerve.

## CHAPTER IV.

### OPERATIONS ON NERVES.

**Primary Neurorrhaphy. (Nerve Suture.)**—The instruments usually required are an Esmarch bandage, scalpel, dissecting forceps, blunt hooks and retractors, artery forceps, needle-holder, curved needles, ordinary sewing needles and sheep-gut.

The wound should be enlarged if necessary, preferably in a direction parallel to the course of the nerve, and its ends exposed. If the nerve is merely divided and there is no loss of nerve structure the ends should be coapted by sheep-gut sutures introduced with a sewing needle. This



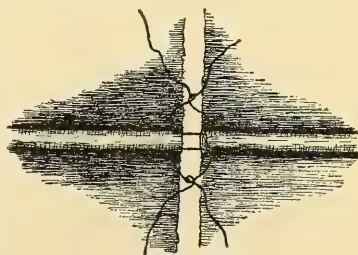
**Fig. 500.**  
**Para-Neural and Direct Sutures**  
**Combined.**

does not lacerate the nerves as much as the ordinary surgeon's needle. The sutures may be passed directly through the nerves as shown in Fig. 500, or the para-neural suture may be employed (Fig. 501). In this the suture is passed through the para-neural sheath or connective tissue. Both methods of suture may be combined, as in Fig. 500. This procedure is frequently successful. The most scrupulous

care should be exercised to keep the wound aseptic. The nerve may resume its function within a few days or it may not for weeks. In the meantime the nutrition of the muscles should be maintained by massage and electricity.

The ends may also be united by splitting one end and paring the other down to a chisel-like end, inserting the latter into the split where it is maintained by sutures. (Fig. 502.)

After any form of nerve suture the limb should be put at perfect rest in that position which will insure the greatest degree of relaxation to the sutured nerve. To maintain such a position a splint should be applied.



**Fig. 501.**  
**Para-Neural Sutures.**

**Nerve-Splicing and Nerve-Grafting.**—When there has been considerable loss of nerve tissue coaptation of the nerve-ends as advised above will be found impossible. When stretching fails to bring the ends into apposition the torn or ragged ends may be cut off and two or more long sheep-gut sutures introduced to hold the severed ends opposite each other while regeneration is becoming established. In some cases where end-to-end coaptation is impossible it is advised that the distal end be attached to some adjacent nerve, after the point of contact in the latter has been freshened for apposition, or the sound nerve is slit and the distal end stitched into this. Another method, when the ends cannot be



approximated, is to cut the nerve about half through with a very sharp knife. This partial cross section should be made at some distance from the end—depending upon the space to be bridged over—and from this point the nerve should be split to within a quarter of an inch of the end and the strip turned over to meet the other nerve end. (Fig. 503). If the strip from one end is not sufficient both nerve ends may be split in the same way and the ends of the strip sutured. (Fig. 504.)

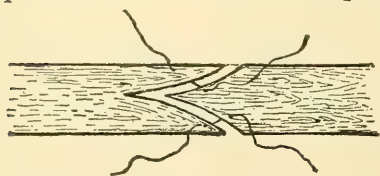


Fig. 502.

**Neurorrhaphy by Splitting End of Nerve and Inserting the Other.**

of nerve sufficiently long to fill in the space between the nerve ends is taken from a recently amputated human limb and united end-to-end with the wounded nerve. (Fig. 505)

It is not always possible to obtain the interposed piece of nerve from the human subject, in which case it may be taken from one of the lower animals, as the rabbit, kitten or dog. Some encouraging successes have followed such transplantation.



Fig. 503.

**Nerve Split and Turned Over to add Length.**

When a portion of a nerve is destroyed by a tumor, callus or otherwise, and it becomes necessary to resect a portion of it, the ends may be united by some of the above methods. When the nerve is found only partially severed or an atrophied portion is discovered, the healthier portions of the nerve may be joined by the method shown in Figs. 506 and 507.

**Secondary Neurorrhaphy.**—When the division of the nerve is not



Fig. 504.

**Strips Split from Both Nerve Ends and United.**

recognized, or is neglected at the time of the injury, secondary suture becomes necessary. This is more difficult and less promising

than the primary operation. The supra-neural structures are laid open freely and the nerve-ends sought for. This may require some patience and plenty of working space, rendered bloodless by an Esmarch bandage. The proximal end will usually be found with less difficulty than the distal end, which will have wasted if a considerable period has elapsed since the two were separated. In this case the ends, especially the proximal, will be bulbous. The ends should be freed from the surrounding structures and the bulbous ends cut with a keen knife.



Fig. 505. Nerve Grafting.

Approximation and coaptation will usually be possible after stretching, although the stretching of the proximal end may be interfered with by the Esmarch bandage. There should be as little bruising of the nerves as possible. If it becomes necessary to grasp or steady the ends with forceps, and the fingers of the assistant are in the way, the author recommends that a bit of soft rubber

drainage tube be first slipped over each jaw of the forceps. The nerve-ends are then sutured as before described.

**Neurectomy and Neurotomy.**—Neurectomy, or excision of a portion of the nerve, is usually performed for the relief a painful nerve or a distressing muscular spasm. The nerve is exposed by a longitudinal incision as in the ligation of arteries, cleared from the surrounding structures for some distance and a blunt hook or the finger passed be-



Fig. 506.  
A Defect in a Nerve.

neath it and thus the nerve is put on the stretch, drawn well out of the adjacent structures and a piece excised. The faradic current is sometimes used, when there are a number of nerve trunks lying in juxtaposition, in order to distinguish, by its muscular responses, which is the nerve the surgeon desires to cut. The piece removed may consist of a number of branches and be two, three or more inches in length. Even after this union and regeneration occur. Turning back the ends of the nerves and interposing between them bits of fascia, bone or muscle are some of the attempts that have been made to prevent re-union. When the painful nerve passes through a bony foramen the nerve is cleared to the opening of the canal and then pulled upon in order to separate the nerve some distance within.

Neurotomy is done for the same affections, but is far less efficacious than neurectomy because of the rapid re-union which is likely to follow. It is sometimes done subcutaneously, but it is preferable to expose the nerve by an incision and then cut it.

**Neurectasy (Nerve-Stretching).**—This is performed for the relief of the same affections for which neurotomy and neurectomy are performed, namely, painful nerves and muscular spasm. It has also been employed with some degree of success in cases of anesthetic leprosy. Stretching the nerve is sometimes resorted to before trying either neurotomy or neurectomy. Nerve-stretching is performed by exposing the nerve, separating it from the surrounding structures, when the fingers can be passed beneath it and the nerve be thoroughly stretched. If the nerve be short or small a blunt hook may be used instead of the fingers. Bloodlessness is not so important here as in either primary or secondary neurorrhaphy, and the Esmarch bandage may be removed after the nerve is freed from the adjacent tissues. If left in place it is likely to interfere with the stretching of the proximal portion of the nerve. This should not be overlooked, because the proximal portion is the one which permits of the greater amount of stretching, although traction should be applied in both directions. Stretching the nerve from the periphery towards the spinal cord is advised in cases of muscular spasm because it seems to have a greater influence upon the motor fibres. The tension is reversed when it is desired to influence the sensory fibres for the relief of pain.

In reference to the amount of force to be applied there can be no definite rule given, but traction should be desisted from when the operator perceives a marked elongation of the nerve or the tearing away of



Fig. 507.

Repair of a  
Defect in a  
Nerve.



some of the nerve fibres. Neurectasy is not always successful, although it not infrequently affords relief for a considerable period.

**Operations on the Cranial Nerves and Ganglia.**—The branches of the trigeminal nerve are frequently subject to distressing pain which defies all methods of treatment and compels the patient to seek relief by operation. This is usually a combination of neurectasy and neurectomy. The relief is not usually permanent, but months and even years may elapse before the pain recurs, when the patient will very likely demand a repetition of the operation. Even the temporary relief afforded is a boon to those afflicted. The recurrence of the pain demands removal of the scar of the former operation, stretching the old stump if possible, exsection of the nerve near the brain, or removal of its ganglion.

Besides the usual knives, dissecting forceps, hemostatic forceps, needles, needle-holder, scissors, etc., the instruments required for these operations will be retractors, strong grooved directors, small chisels and gauges, a slender blunt hook, bone drills, raspatories and bone elevators, one-half inch and inch trephines—one with a long shank—small curettes, a Hey's saw, a head mirror and electric light.

**THE SUPRA-ORBITAL BRANCH.** This is exsected by making a horizontal or curvilinear incision below or within the eyebrow. The nerve emerges through the supra-orbital foramen or notch, but either can generally be felt. The nerve is usually found without difficulty, the fat is pushed downward out of the way and a hook is placed upon the nerve, which is followed and pulled upon with considerable force and then divided as far back as possible, when traction is made upon the free end to pull out the terminal fibres.

**THE SUPERIOR MAXILLARY DIVISION OF THE TRIGEMINAL NERVE.** A line running downward on the same side from the supra-orbital notch or foramen, between the two lower bicuspid teeth, will intersect the infra-orbital foramen about one-quarter of an inch lower than the inferior margin of the orbit. The simplest removal of the infra-orbital nerve is performed by making a slightly curved incision parallel with and just below the orbital margin, and the nerve will be found beneath the levator labii superioris muscle. (Fig. 508).

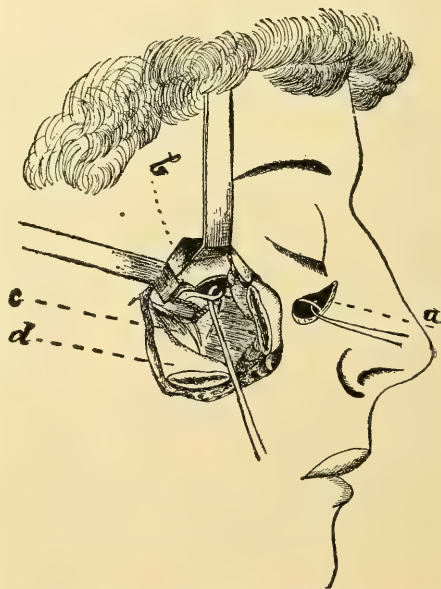


Fig. 508.

a. Infra-Orbital Nerve; b. Superior Maxillary Nerve, Meckel's Ganglion; c. Temporal Tendon; d. Zygomatic Arch Sawed and turned down.

When the nerve is exposed it should be grasped at right angles with a pair of hemostatic forceps, around which the nerve is twisted when traction is necessary. Some use a silk ligature for the same purpose. The orbital tissues are raised, the periosteum may be lifted, the floor of the orbit is broken through by the pressure of the grooved director or other instrument, the



nerve, caught and lifted with a small blunt hook, is put well on the stretch by means of the forceps or ligature and divided with curved scissors as far back in the orbit as possible. If the periosteum is stripped up this may be as far back as the foramen rotundum and include the sphenopalatine ganglion. After division of the nerve it should be pulled upon till its terminal filaments give way.

**MECKELS' GANGLION.** This is removed with the preceding nerve by making an incision similar to the one just described and adding another in a downward direction, making a T-shaped incision. The infra-orbital nerve is caught as above and the antrum is opened with a chisel or good sized trephine (three-quarters of an inch to an inch). This opening includes the infra-orbital foramen. Then, in the same way, another opening is made through the posterior wall of the antrum, working cautiously to avoid injuring the internal maxillary artery behind the bone. The floor of the orbit is broken through, the nerve pulled down into the antral cavity and by following it backward the ganglion is found in the sphenomaxillary fossa. The nerve is now severed with curved scissors, just in front of the foramen rotundum and posteriorly to the ganglion, and the terminal filaments are torn out by traction. Packing with gauze is usually sufficient to control the hemorrhage.

Another method is to make a V-shaped incision, with the apex slightly below and behind the external angular process of the frontal bone, the lines of incision being carried downward, one upon the cheek to the level of the tragus, the other directed somewhat backward to the tragus. The soft structures are retracted, the zygomatic arch is exposed and perforated by small drills for the subsequent insertion of sutures. Both extremities of the arch are to be sawed after the suture holes are drilled upon both sides of the line to be sawn through. After this is done the pterygo-maxillary fissure is exposed by liberating the temporal fascia and turning down the zygoma, when the ganglion may be discovered and cut as before. The infra-orbital nerve may be removed at the same time by making the infra-orbital incision previously described, loosening the nerve and retracting it through the pterygo-maxillary incision. The zygoma and other tissues are replaced and sutured and the wound dressed in the usual way.

**INFERIOR DENTAL NERVE.** This nerve sometimes requires resection. It may be done through the mouth by making an incision through the mucous membrane along the anterior border of the ramus of the inferior maxilla. The incision runs from the last upper to the last lower molar tooth. The finger is pushed into the wound, the internal pterygoid muscle is forced away from the inner surface of the ascending ramus and the bony projection indicating the position of the inferior dental canal is felt. The nerve is now sought for with a curved, blunt hook, is stretched and excised. The internal lateral ligament should not be mistaken for the nerve.

The nerve may be reached by an external incision about two inches long and just behind and below the angle of the jaw. The skin and muscles are drawn upward so as to expose the jaw-bone at a point a little over an inch from the angle, to this a half inch trephine is placed and a button is removed. This should expose the inferior dental canal, which the nerve enters. The nerve is picked up on a hook, stretched and excised. Some prefer to follow the nerve by chiseling the canal and laying it open

upon the outer surface of the maxilla to the foramen, and removing the nerve. This step is likely to be attended by the division of the inferior dental artery, but the hemorrhage is readily controlled.

Another method of reaching and removing the inferior dental nerve is by making an incision from the median portion of the zygoma down to the angle of the jaw, then forward, conforming to the outline of the angle and the posterior and inferior border of the jaw. The facial artery need not be included in the incision. The skin flap is peeled upward and the deep fascia and masseter muscle cut across. The line of incision should be below Stenson's duct and run in the same direction. The periosteum is elevated and a half inch trephine is made to remove a button of bone at a point about one-half inch below the sigmoid notch. Then the narrow neck of bone between the notch and the newly made opening is removed with a chisel, drill or saw, according to preference, and the sigmoid notch thus deepened. The inferior dental nerve is next exposed by working through the periosteum upon the inner surface of the jaw bone. The nerve is followed, stretched and excised as close to the foramen ovale as possible.

**LINGUAL NERVE.** This nerve, which lies a little more deeply and a little anteriorly to the inferior dental, can be removed with the latter by the preceding method.

It may be reached through an intra-oral incision. A suture or tenaculum steadies and puts the tongue upon the stretch on the side to be opened. The nerve can then be felt, like a tense sub-mucous band. The mucous membrane is incised and the nerve hooked up, stretched and excised.

It lies in juxtaposition to the inferior maxillary bone, beneath the mucous membrane and immediately below the first molar tooth, and may be reached here when the tongue cannot be drawn to one side, as in some cases of carcinoma.

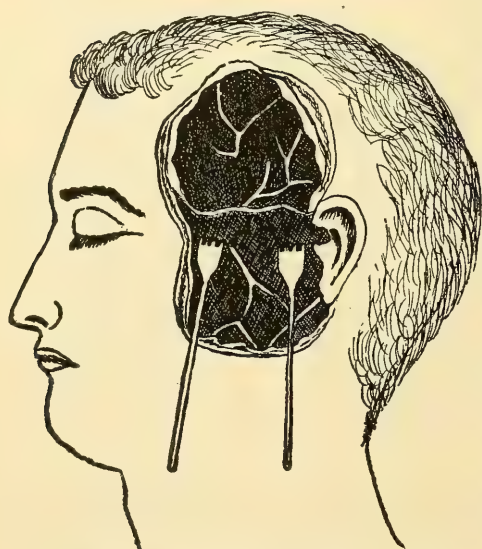


Fig. 509. Osteoplastic Flap turned down, exposing middle Meningeal Artery and Dura Mater

times necessary for recurring pain after neurectomy. One route is through the temporal region, by means of an incision, as shown in Fig. 509. The posterior extremity of the incision is close to the tragus, its anterior ending at the external angular process of the frontal bone. The uppermost curve of the incision is close to the temporal ridge. After the musculo-cutaneous structures are cut through the bone is divided in a corresponding line by means of a chisel. The usual care will be exercised to insure against its being driven through, by using a chisel with two rectangular cutting edges. After the groove is sufficiently deepened a bone elevator is used to pry out the bone, which is thus fractured at the base of the incision and which is turned down with skin and mus-

**GASSERIAN GANGLION.** The removal of this ganglion is some-



cles still attached. (Fig. 509). This brings the dura mater and the middle meningeal artery into view. The temporal lobe is carefully elevated from the base of the skull and the three divisions of the trifacial nerve are recognized and followed to the dura, which is divided, thus exposing the Gasserian ganglion. After gently scraping away the ganglion the osteoplastic flap is replaced and sutured. If the hemorrhage is profuse the wound may be packed and the operation completed after forty-eight hours, when the bleeding will be less troublesome. The ganglion is sometimes removed by an opening through the base of the skull. It lies in a depression near the apex of the petrous portion of the temporal bone, with its upper surface in contact with the dura mater, and with the cavernous sinus near its inner side. The operative steps consist of drilling and double section of the zygoma, liberating the masseter and temporal muscles, and removing the coronoid process of the jaw. A half inch trephine with a long shank is applied around the foramen ovale and a button removed. Following the nerve trunk inward will indicate the position of the ganglion, which is removed by a small curette carefully manipulated. The outer structures are thus replaced and sutured.

For operation on the facial nerve, see Spasm of the Facial Nerve.

**Treatment of Painful Stumps and Scars.**—The stump end should be opened and imprisoned nerve-ends sought for, and when found severed with a keen-bladed scalpel. This subjects the nerve to less bruising than severing it with the scissors. The division of the nerves should be made above the cicatrix, and this is facilitated by clearing away the surrounding structures and pulling the nerve down. When the bulbous nerve has undergone ascending neuritis this treatment is likely to be ineffective, and a high neurectomy—perhaps as high as the sensitiveness of the nerve can be demonstrated—or re-amputation then becomes necessary. Sometimes the surgeon may not find nerves of any size entangled within the scar, in which case he dissects out the entire cicatrix and coapts the flaps carefully. In the latter case perfect primary union is the desideratum; the linear cicatrix of a properly coapted and well-healed stump offers the smallest possible area for the entanglement of nerves or their filaments.

In painful cicatrices, other than those of stumps, the treatment is practically the same. The scar should be dissected out, the surface coapted and every precaution taken to obtain primary union. Occasionally a nerve is caught in an inflammatory exudate or even in the bony callus after a fracture, as, for instance, the ulnar nerve after fracture at the elbow. The pain from this may be so severe and intractable as to demand incision and liberation of the nerve, and even the use of the chisel or rongeur may be necessary in order to remove the callus.



## SECTION XIX.

# SURGERY OF THE RESPIRATORY SYSTEM.

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## CHAPTER I.

### SURGICAL DISEASES OF THE NOSE.

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**Deformities.**—Deformities of the nose may be (a), congenital, (b), the result of some pathological process, and (c), the result of injury. The deformity may be external, affecting the skin and general contour of the nose, or, from some change in the bone and cartilage, affecting the shape and size. Again, the deformity may be internal only, modifying the mucous surface and the lumen of the nasal passages.

**CONGENITAL DEFECTS.** These vary from entire absence to hyperdevelopment so great as to resemble a double nose. A fissure between the lateral cartilages—causing a bifid nose—or an especially short dorsum—causing an excessively snub nose—may be results of non-development.

The congenital class of defects most frequently affect the contour of the internal passages, and the most common is that of a deviated septum, which may occlude one nostril absolutely or only partially, thereby affecting the growth of the nose, and from the pressure on the turbinated bone often producing reflex nervous irritations, seriously affecting the development of the individual. The nostrils are sometimes occluded by a membrane from birth.

Fissures of the nose are almost always associated with other congenital defects, as hare lip or cleft palate.

It is rare that a nose is absolutely symmetrical; but sometimes a slight variation at birth is increased by irregular development which is dependent upon stenosis of one nostril and obstruction to the nasal passage by hypertrophy of the mucous membrane, enlarged tonsil or adenoid growths in the nose or pharynx.

Deformities due to pathological changes, such as necrosis of bone or cartilage, tumors in the nose and pharynx, and morbid processes in the sinuses, are not infrequent.

**Rhino-scleroma.**—This is a chronic affection of the skin and mucous membrane of the nose and naso-pharynx, characterized by development of intensely hard, nodular growths. It begins in the septum, or in one or both alæ. The first symptoms usually attracting the patient's attention are a change in the shape of the nose and a feeling of hardness to touch. These symptoms steadily increase, the nodular character developing more and more until the nose grows broad and flat and the surrounding skin becomes more involved, so that it moves with the growth,

which is unattached to the bone or cartilage. The ivory-like hardness increases, the nostrils flatten. The skin directly over the nodule may appear normal, or smooth, shining, devoid of hairs and follicles, pale, and traversed by dilated blood vessels of purplish tinge. There are no subjective symptoms except on firm pressure, which causes a severe, lasting pain. The growth steadily progresses, producing stenosis of the nasal passage or affecting the tear-duct. If it encroaches on the pharynx it may affect deglutition and ultimately involve the larynx. Ulceration is likely to occur, especially on the mucous membrane. It is due to the action of a specific bacillus, the bacillus rhino-scleromatis. The characteristic hardness differentiates it from syphilitic nodules, carcinomata and sarcomata. These also ulcerate but degenerate much sooner and more rapidly. The prognosis is unfavorable for a permanent cure as it is liable to return when removed.

**TREATMENT.** The treatment is thorough and early extirpation, with the knife or curette, of all the growth and skin that are at all affected. A plastic operation or skin grafting can be done to cover the defects.

**Elephantiasis.**—Elephantiasis rarely affects the nose in middle or later life. The treatment is excision and plastic or skin grafting operation to cover the wound.

**Carcinoma.**—Carcinoma in the form of epithelioma frequently attacks the nose at the alæ, on the line of skin and mucous membrane, and often encroaches upward into the nose. The very slowly growing variety, sometimes called rodent ulcer or Jacob's ulcer, often starts at the same place and gradually destroys all the tissues of the nose. It may begin at the corner of the eye and gradually encroach on the nose from that direction. When it starts from above it affects the bones sooner.

**DIAGNOSIS.** The symptoms of the more rapid and slower growing variety are at first the same. Usually a small nodule first appears, and gradually enlarging is soon followed by an ulceration that is surrounded on all sides by a line of induration. It sometimes has the appearance of a small wart at first, which gradually breaks down. This is often hastened by attempts to cure by cauterization. There is a watery discharge from the sore. Scabs often form and as they fall off are picked off an added encroachment into the surrounding tissues is noticeable. The lymphatic glands in the submaxillary and cervical regions are usually enlarged, in proportion to the rapidity of the growth of the tumor and the length of time it has existed. Pain is not always present at first. Later there is burning or lancinating pain, and soreness to touch and pressure, less prominent in rodent ulcer. The glandular enlargement and peripheral induration accompanying the very slow-growing rodent ulcer is often not noticeable until the destruction of tissue is quite advanced.

The differential diagnosis between carcinoma and sarcoma, syphilitic nodules, tubercular ulcerations and lupus is not difficult. Carcinoma rarely occurs before the age of forty, usually between forty and seventy. The others occur before forty. Sarcoma seldom primarily attacks the nose, and is nearly always found in young subjects. Syphilitic nodules and subsequent ulceration are always accompanied with a specific history and other signs that are characteristic. Anti-syphilitic medication for a

few weeks, mercury in different forms, especially proto-iodide, or potassium-iodide, will have no effect on carcinoma, but will improve a syphilitic lesion. Tubercular ulcerations and lupus are easily diagnosed by the tubercle bacilli—which are always present—the age, from youth to the age of forty, and the family history.

**PROGNOSIS.** The prognosis is unfavorable unless operative interference is employed early; unfavorable in the steady progress of the tumor, the danger of metastasis to the neighboring glands, and by danger of general carcinosis and tendency to recurrence. It is favorable if excised before there is wide-spread induration and glandular involvement.

**TREATMENT.** The treatment is free excision at as early date as possible, followed by internal medication for a long period. Plastic operations and skin grafting will assist greatly in modifying the deformity and lessening the amount of granulation necessary in healing, thereby affording less fertile ground for the recurrence of the disease, having, as it does, a predilection for granulative tissue.

The homeopathic remedies should be carefully chosen. *Arsenicum album*, *cuprum*, *conium*, *calcarea carbonica*, or the iodide, *belladonna*, *carbo vegetabilis*, *gelsemium*, *hydrastis canadensis*, *rhus tox.*, *phytolacca*, and *cedron* may be indicated. The local treatment, exclusive of the use of the knife, is only palliative. Cauterization, either by the thermo-or actual cautery, or by the application of caustic pastes, is to be condemned, especially in carcinoma, situated where the bone and cartilage lie so near the surface as in the nose and face. If inoperable, the ulcerating spots are to be kept free from putrefaction by the daily or more frequent washing with some antiseptic solution, as bichloride, one to four thousand or five thousand, or three to five per cent. solution of carbolic acid. Peroxide of hydrogen is of service where suppuration is profuse. A one to eight solution of *succus calendula*, used as a wash or applied on pledgets, sometimes relieves the pain and retards suppuration. As a rule these ulcerating carcinomata do better without cerates. But a cerate with vaseline or cosmoline as a base is much to be preferred to those that are more liable to putrefaction. One of the best is a naphthalin cerate composed of twenty to fifty grains of naphthalin and a sufficient quantity of ether to thoroughly admix with an ounce of vaseline, to be used in strength just short of the production of a burning sensation.



## CHAPTER II.

### INJURIES OF THE NOSE.

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**Distinctive Considerations.**—Wounds of the nose, as of other soft parts, are contused, incised and lacerated. The principal precaution in wounds of this region is that especial care should be used to prevent cicatricial contractions and to save as much tissue as possible.

It is difficult to get healing without suppuration if the mucous membrane is implicated. Close adjustment of flaps by numerous fine sutures lessens the probability of large cicatrices. One of the best sutures is prepared horse-hair. If, in order to get close adjustment, there is sufficient strain to run the risk of slough the flaps can be loosened by subsection for some distance on the cheeks, stretched and slipped into place with less tension. The lumen of the nostrils should be maintained by plugs of gauze or pieces of rubber tubing. Especial care is necessary to prevent cicatricial contractions in burns and scalds. The nostrils should be kept dilated to their fullest extent during the entire process of healing. In burns that have not destroyed the mucous membrane recourse should be had to Thiersch skin-grafting as soon as the slough comes off and a bed of granulative tissue is formed. This often prevents severe deformities of the nose and face.

**Emphysema.**—Emphysema of the nose and face often accompanies wounds of the nose where the mucous membrane is implicated, or in cases of compound fracture of the bones of the nose where the opening is on the mucous surface. This is not a serious complication in itself, unless the air forced into the tissues carries with it germs of putrefaction or suppuration. The appearance of the face is usually very alarming to the laity, the swelling often distorting the features to a great degree. It is most frequently produced by blowing the nose in order to force out blood clots which may have formed, or to relieve the obstruction caused by swelling or displacement of the bones and tissues.

**DIAGNOSIS.** The diagnosis is made by palpation with the tips of the fingers, which discloses a fine bubbling crepitation. This need not be confounded with the crepitation of a fracture, which requires some manipulation.

**TREATMENT.** Treatment is seldom required for simple emphysema. If cellulitis is started incision for the relief of tension should be promptly made. As soon as there is a sign of emphysema in fractures the nose should be washed out with a carbolized or borated solution and the nares plugged with iodoform-gauze. Attempts to clear the nose by very forcible blowing are to be deprecated.

**Fracture of the Nose.**—Fractures may include not only the nasal bones, but also the septum, nasal process of the superior maxillary, and the nasal spine of the frontal bones. They may be simple, compound or comminuted. They are most frequently the result of direct violence, and are frequently compound, either through the skin or the mucous membrane.

They may be associated with fracture of other bones in proximity, the most important of which is fracture of the cribriform plate of the ethmoid bone. The displacement is usually directly backward, or backward and to one side, according to the direction of the force. Fractures of the nasal bones are frequently overlooked, because of the rapid swelling and ecchymosis which usually take place. As the manipulation of the injured member gives considerable pain it is often difficult to make a satisfactory diagnosis.

**SYMPTOMS.** There are deformity, abnormal mobility and crepitation. Unless the swelling is very great the deformity is usually quite obvious. The abnormal mobility and crepitation can be made out only by manipulation. It is often necessary to lift the bones from the inside, and as this usually causes much pain and reflex irritability it is illy borne by the patient. Bleeding from the nose is often present, and occasionally emphysema of the nose occurs from efforts of the patient to blow the obstruction from the nostril. If a positive diagnosis cannot be made on account of the pain it is well to use an anesthetic. Examination should not be postponed, as the progress of ossification is very rapid in these bones. Another reason for immediate diagnosis and prompt treatment of these cases is the tendency of these bones to necrose if the manipulation be kept up for any length of time.

**PROGNOSIS.** The prognosis is favorable as regards life, except in those cases in which the fracture has run into the cribriform plate of the ethmoid bone, when meningitis is sometimes developed. As regards deformity, however, the prognosis is not so favorable. The deformity is extreme in cases where there has been loss of substance, or where the nasal bones remain depressed on a line with the superior maxillary.

**TREATMENT.** This consists in the reduction of the displacement and maintenance of the reduction by some retentive apparatus or dressing. Reduction is attempted by pressure exerted on the inside of the nostril, and aided by manipulation or moulding of the fragments from without. Owing to the narrowing of the channel between the nasal bones and septum, pressure from within must be afforded by a thin, firm instrument, such as a director or steel probe. After once reduced there is little tendency to another displacement of the fractured part, except in cases where there is a wound through the skin or mucosa. The use of plugs of gauze within the nostril to keep the fragments in position is not to be advised, except in cases where emphysema is developed in connection with a wound of the mucous membrane, when a light packing of iodoform-gauze should be used. Dressings outside of the nose are not so valuable for maintenance of reduction as in preventing further injury. Of course if there is a wound of the skin and soft parts dressing is necessary, but in the majority of cases it is preferable that no dressings be used. The frequent inspection of the nose and replacement of any subsequent deformity by gentle manipulation gives as satisfactory results as any method. Where the depression of the nasal bone is so great that reduction cannot be maintained it is advisable to transfix the nose close beneath the fragments with a silver or nickel-plated pin, maintaining the pin in position by adhesive plasters carried over the bridge of the nose and ends of the pin. The needle is left in place for ten days. Any tendency to suppuration should be combated by proper means. The injection into the nose

of a calendula solution, and washing the wound, if there be one, with calendula or antiseptic solution tend to reduce the swelling and consequent danger of suppuration. In old cases, where the adhesions have been in bad position, relief of the deformity can sometimes be accomplished by a re-fracture of the nose. This is best done by a clean incision and the use of a chisel, always with the attempt to get primary healing. The use of cocaine in the nostrils aids materially in the diagnosis and treatment of these cases.

Fracture or dislocation of the septum alone sometimes occurs. Where the impaction of the nasal bones is very great and the violence unusually severe implication of the ethmoid bone may be suspected. Absolute rest and quiet should be insisted on for a few days for fear of meningitis.

**Periostitis and Osteitis.**—Periostitis and osteitis of the bones of the nose may be the result of injury or disease. Syphilis, inherited or acquired, and tuberculosis most frequently cause it. The loss of only a little of the bone may cause such marked change in the contour of the face that especial watch should be kept when any suspicious symptoms in this region develop in the course of syphilis. Where implication of bone comes on slowly from an ulcerative process on the mucosa the symptoms at first are hardly different from those due to ulceration. Where independent of ulceration, the symptoms are edema of the skin, redness, and tenderness on pressure. Pain is usually present, of a dull character and frequently with night aggravation.

**TREATMENT.** The treatment is constitutional at first, if due to any constitutional disease. An incision should be made at the place of greatest redness, if there is any tendency to "point," and if the delicate use of the probe discloses any necrosed bone it should be removed. If caries is obvious the bone should be scraped down to healthy substance. The application of iodoform is of benefit, and packing the wound with narrow strips of iodoform-gauze should be resorted to in case there is communication with the mucous surfaces. This should be changed when wet, and kept up until healthy granulations are started, when the packing is omitted and the edges of the wound are brought together and dressed as in ordinary wounds. The scar and destruction of bone are apt to be much less than when the discharge is permitted to ulcerate its way through the skin.

The remedies are the mercurials, especially proto-iodide, and the kalis, the bichromicum having an especial effect on the bones of the nose in syphilitic cases. Silicia, lycopodium and calcarea are to be thought of when there is a tuberculous history.

**Foreign Bodies in the Nose.**—Foreign bodies of almost every description find their way into the nose, either through accident, or by design. They may be introduced from without, and through the nasopharynx, the latter occurring during efforts at vomiting or violent coughing, when some foreign body is drawn into the throat or larynx and then forcibly expelled by a reflex attack of coughing, lodging in the nose. A foreign body introduced this way is usually expelled because of its irritating influence upon the Schneiderian membrane; but if it remains long, even though small, it may cause swelling of the folds of the mucous membrane, which will make its extraction difficult. Again, the foreign



body may be impacted and carried back into the narrower parts of the nose by efforts directed toward its extraction. In children it may not give rise to any symptoms calling attention to its presence until it has remained long enough to induce ulceration or hemorrhage. Where the substance introduced is liable to swell by the absorption of moisture the impaction may be so great as to make it a difficult operation to remove the foreign body. The symptoms of foreign body in the nose are usually unmistakable, as occlusion of the nostril, complete or incomplete, and sometimes acute congestion of the mucous tract, which shows itself by sneezing and running from the nose.

**TREATMENT.** When it can be seen the removal of a foreign body from the nose is usually very simple. It should be grasped by a pair of thin, narrow-bladed forceps and extracted; or if attempts at the introduction of the forceps seem to push the body further into the nose a probe can be bent near the point, introduced at one side and carried behind the foreign body. Sufficient counter-pressure can thus be exerted to permit of the introduction of the forceps or snare. (Fig. 510). In young children, where the use of cocaine does not sufficiently allay the pain so that they can be controlled, an anesthetic is necessary. In adults, or children who can be reasoned with, the instillation of a few drops of five per cent. solution of cocaine will not only allay the pain and reflex irritation, but will sometimes relieve the congestion of the mucous membrane to such an extent that the operation for extraction of the foreign body is comparatively easy. Sometimes the foreign body is carried so far back that it is impossible to extract it through the external meatus. In these cases it should be pushed back so that it will drop into the naso-pharynx, whence it should be removed.

The forcible blowing of air into either nostril by means of a Politzer bag or through a tube, the nostril being closed around the tube, will expel the body as the result of air pressure from behind. Usually simpler procedures will suffice and should always be tried, although former experience may not have been wholly in their favor.

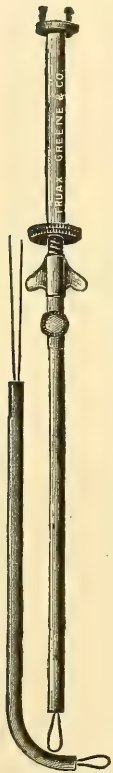


Fig. 510.  
Snare.

**Rhinoliths.**—These are deposits of earthy salts about some nucleus of small, foreign particle in the nasal passages. They vary in size from an eighth of an inch to three-eighths of an inch in diameter. They are usually found in one nostril and may be single or multiple. When in process of formation they do not give rise to many symptoms, but when there is a number present or they attain some considerable size they may give rise to symptoms resembling those due to the presence of a foreign body. There is nasal discharge, obstruction, and often a loss of the sense of smell. There is always a marked fetor. On examination rhinoliths may sometimes be seen, usually covered with mucus, either partially dried or decomposed, so that they are discolored and look like pieces of detached bone. A grating feeling is imparted to the probe, resembling necrosis.

**DIAGNOSIS.** This can usually be made by a thorough examination, under dilatation and illumination.

**TREATMENT.** This is removal by small-bladed forceps, or dislodgment of the body from the mucous membrane with a spoon.

Where the rhinolith is so large that it cannot be removed *en masse* it is necessary to crush it with the aid of strong forceps.

In removal by piecemeal there is usually a tendency to re-formation. This should be combated by local treatment, in the way of sprays or douches, kept up for months after the operation.

**Parasites.**—Parasites, such as insects and worms, sometimes locate in the nose. In the more tropical regions other insects and worms lodge in the nose, but the most frequent example in this country is the maggot. The damage does not result so much from the insects and worms themselves as from the larvæ or eggs deposited in the folds of the mucous membrane. Later, the development of these deposits causes serious trouble. In children with a profuse catarrhal discharge the fetor often attracts flies which, during sleep, deposit their eggs. These are later hatched as maggots. The mucous membrane may be destroyed by these insects and necrosis of the bone and cartilages follow.

**SYMPTOMS.** The chief symptom is the intense itching, which may be to such degree as to produce convulsive attacks in nervous, irritable children. There is usually a reflex headache, especially in the region of the frontal sinuses. Frequent hemorrhages may be the result of localized ulceration or arise from violent attacks of sneezing. There may also be cellulitis of the nose and face, of a very severe character. In warmer countries where the larvæ are deposited in large numbers and developed rapidly fatal symptoms may be produced in the course of a few hours. When the maggots are once hatched they are usually seen in the discharges, or around the nose.

**TREATMENT.** Douches of a weak solution of bi-chloride or carbolized water or a boracic acid solution should be used. The douches should be as frequent as three or four times daily until all signs of the trouble have passed away. Inhalations of chloroform have been suggested, but do not take the place of antiseptic douches.

### CHAPTER III.

## TUMORS OF THE NASAL PASSAGES.

**Frequency.**—Tumors of the nasal passages are frequent, such as myxomata and myxo-fibromata. These are usually in the form of polypi. Next in frequency are vascular tumors, angiomata and adenomata. The tumors may be bone and cartilage, and are rarely sarcomata or carcinomata.

**Polypi.**—Polypi are usually composed of mucous tissue, there being a stroma or network of fibrous connective tissue of greater or less firmness, the inter-spaces of which are filled with a gelatinous substance. They may be pear-shaped or with a pedicle of some length, of a pale, pinkish tint, opaque, varying in size from a quarter of an inch to an inch in diameter. They usually cause some annoyance from their obstruction and irritation of the Schneiderian membrane, as the result of their free extremities moving during respiration. They may be multiple or a single polypus may gradually fill the entire nasal passage. Fig. 511. They are apt to undergo cystic degeneration. They do not become attached to the bone or cartilage, and have but a small blood supply and scarcely any nerves.



Fig. 511. Interior View of Nares Showing Polypus Blocking Same.

Myxo-fibromata usually have their origin in the bone or cartilage. They occur most frequently on the middle turbinated body, next on the superior turbinated and rarely on the inferior turbinated bone or meatus. They may extend backward into the naso-pharynx and sometimes into the sphenoidal sinus, but rarely protrude from the nostril. When they attain a considerable size they may become attached to different points of the mucous surface so that it is difficult to determine the point of original attachment.

**SYMPTOMS.** The first symptom of polypi is usually acute congestion. There is a copious secretion of mucus or mucus and pus, and difficulty in breathing through one or both nostrils. There is a feeling of fullness which gradually increases and often there are futile efforts to relieve the obstruction by snuffing. The muco-purulent discharge gradually increases, giving rise to fetor and the characteristic nasal twang of the voice, due to the obstruction. Hemorrhage is liable to occur. The symptoms are all likely to be aggravated by the humidity of the atmosphere or a warm and moist room. Reflex symptoms will probably be associated. Often hearing is lost or impaired, and there is nearly always frontal headache. Where the polypus is very large or there are a great many polypi, they may alter the shape of the nose. The lachrymal duct is sometimes obstructed and the septum displaced to one side. The suppurative process may be so great where the entire nose is filled and where the polypus encroaches on the pharynx that the patient may even have attacks of septicemia or pyemia.



There is very little danger of mistaken diagnosis. Adenoid growths or hypertrophic catarrhal conditions are easily recognized by the application of cocaine, when they are materially lessened in size. The polypi are unaffected by it. Again, polypi can be made to move with a probe, or by forced inspiration and expiration; the others cannot. Malignant growths rapidly disintegrate, the ulceration producing frequent attacks of epistaxis and a foul discharge, in which can be seen shreds of superficial slough. Sarcomatous degeneration of what was primarily a purely non-malignant myxoma occurs, but is followed by characteristic symptoms.

**TREATMENT.** This consists in their removal. By using a cocaine solution a general anesthetic is not required, but in children it is often advisable and even necessary to give the latter. The patient should be placed so that the head can be quickly carried lower than the body, as the hemorrhage is often very profuse for a few moments and it is impossible to swab the throat fast enough to keep it clear. One method of removal

(evulsion), Fig. 512, is to tear or twist them off by grasping them about the pedicle with a pair of curved forceps, with long, serrated edges. Often this results in the loss of a portion of the turbinated bone. If there is a decided pedicle excision may be accomplished by a

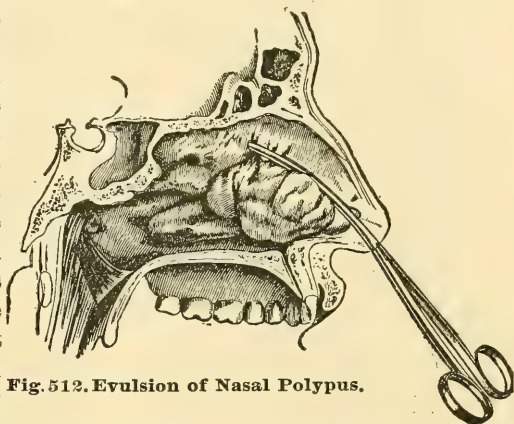


Fig. 512. Evulsion of Nasal Polypus.

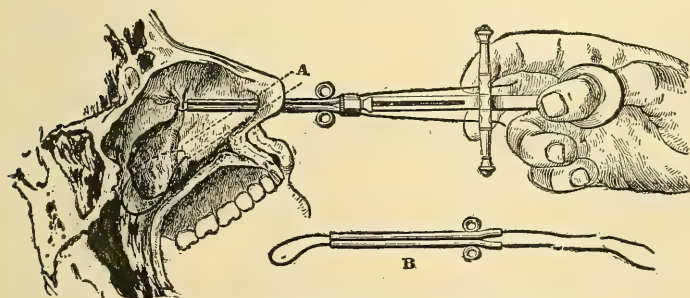


Fig. 513. Removal of Nasal Polypus by Ecraseur.

simple mucous polypus. Where the variety is a myxo-fibroma the bleeding is often severe. A galvano-cautery loop can be used with less danger. Polypi that lie far back or are pushing into the pharynx may require the introduction of the finger into the pharynx so as to adjust the loop if the ecraseur is being used, and also to push the mass forward where it can more easily be worked upon. A gag should be used for this maneuver or a cork wedged back between the molars. The cork should always have a string attached to it to prevent the possibility of slipping down the throat in the event of the patient's struggling. There is a great tendency to immediate recurrence if the removal is not thorough. The operation should be per-

wire ecraseur, Fig. 513. A very flexible wire is the best, the loop being guided into position by a sound or light forceps. The hemorrhage is brisk but usually does not persist after the removal of the

sisted in until there is a clear passage. The application of some stringent solution to the stumps is advisable. Boracic acid in alcohol is good. Tannic acid or sulphate of zinc may be used. Where the point of attachment can be seen by the aid of illumination, touching it with a solution of nitrate of silver, forty grains to the ounce, stimulates healthy granulation.

**NASO-PHARYNGEAL POLYPI.** These are usually fibromata or myxofibromata. Occasionally they are sarcomatous, to a greater or less degree. They grow from the back portion of the nose into the pharynx, or from the periosteum or bone of the pharynx, or in the pterygo-palatine region. They are most frequently met with at puberty and in boys. They are roundish, nodulated masses, pink or bluish in character, covered with a mucous membrane that is extremely vascular. The firmer and more dense varieties grow slowly. The softer varieties increase in size very rapidly. They are exceedingly vascular and bleed easily, and the hemorrhage is sometimes stopped with difficulty where sarcomatous degeneration has involved the blood vessels. They spread in any direction and form secondary attachments, where they may exert pressure for a great length of time. The most frequent locality is the basilar process, spreading forward into the nose and outward into the pharynx. They may occur from the ethmoid and sphenoid bones or start from the back portions of the septum.

*Symptoms.* These depend somewhat on the growth and position of the polypus. The discharge is usually fetid and blood-stained. Epistaxis may be very severe and frequent, the nostrils are obstructed, the Eustachian tubes closed, deglutition may be impeded and the general contour of the face is sometimes changed. In extreme cases they may develop to such an extent as to force apart the nasal bones and give the deformity called "frog-face." Often there is a persistent headache with attacks of vertigo, and sometimes the symptoms suggest the possibility of meningeal involvement.

*Prognosis.* As relates to spontaneous cure it is unfavorable in the majority of cases. While at first they do not endanger life unless they grow rapidly down into the pharynx, they impinge on the larynx, and often the general strength of the patient is materially depleted by the frequent attacks of epistaxis. There is a tendency to return after removal unless the removal be very thorough and the point of origin be properly treated.

*Treatment.* The treatment consists in thorough removal and destruction of the tissue at the point of origin. When the growths are of the smaller size they can sometimes be caught at the pedicle by properly constructed forceps, Fig. 514, curving in different ways to suit the different portions of the pharynx or naso-pharynx, and twisted or cut off, the finger being introduced into the pharynx so as to enable the operator to grasp them with the forceps. Fig. 515. If the excision can be done with the *écraseur* the loop of wire should be adjusted around the pedicle with the forceps or fingers carried down into the pharynx. The galvanocautery loop is to be preferred, as where it is used slowly there is but a minimum chance for hemorrhage. The hemorrhage is sure to be profuse—the larger the pedicle the more alarming. In extreme cases, however, the growth cannot be removed either through the mouth or pharynx,



and sometimes the most daring of surgical operations are required for its extirpation.

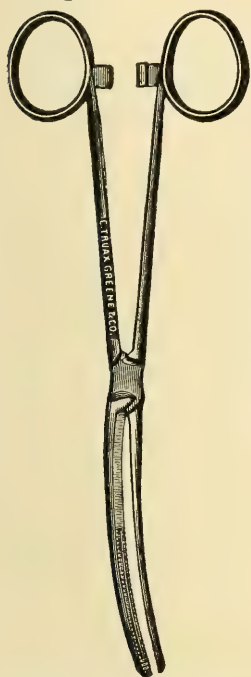


Fig. 514. Robinson's Pharyngeal Polypus Forcep.

Rouge's operation is as follows: The upper lip is seized on each side near the corner of the mouth and turned upward. Incision should be made reaching from the first molar tooth on one side to that on the other, through the mucous membrane at its reflection from the lips to the gum. The tissues between the buccal and nasal cavities are next dissected, and the cartilaginous septum detached with a knife from its insertion into the nasal spine. This may suffice to allow the introduction of a finger and the necessary manipulation for the arrangement of the thermo-cautery loop; but sometimes more space is required, in which case the lateral cartilages should be detached from the maxillary bones, and the nose, then completely freed, can be turned upward on the forehead, widely exposing the orifice of the naso-



Fig. 515. Cohen's Post-Nasal Curette Forcep.

pharynx. The septum may require separation from the maxillary crest.

The removal of the tumor can now be accomplished and after stopping all hemorrhage, searing of the root of the pedicle, by the cautery or some chemical astringent, should be done. The lip and nose can then be replaced, especial care being taken that the base of the septum is placed in exact contact with the nasal spine and is supported by it. Few sutures are required. Little or no inflammatory involvement of the lip need follow this, and the parts are practically healed in a few days.

Langenbeck's operation consists of an incision from the inner angle of the orbit to the malar bone or even the zygoma, and from the alæ of the nostril as far back as and nearly parallel to the first incision and then turning upward to join it. The region of the masseter must be carefully detached as far as exposed. The soft parts are not separated from the bone. Then two incisions are made through the bone to the retro-maxillary fossa. These are made from behind forward, the upper passing through the malar bone, the malar process and facial surface of the superior maxillary to the inner angle of the orbit, also parallel to this above the alveolar border. A straight, narrow saw, with a movable back which allows the blade of the saw to pass through the bone into the mouth, should be used. The bone is then freed from behind, above and below, and can be levered out from the pterygo-maxillary fissure, turning on its hinge, composed of skin periosteum and mucous membrane, in the central line of the nose. The entire naso-pharyngeal cavity and retro-maxillary space are thus exposed. The tumor is easily extirpated,



the bleeding points properly secured and the pedicle carefully seared. The bone is now carefully replaced, secured by very fine ligatures of sheep-gut in three or four places, the soft parts carried over and secured in an accurate position by sutures, some of which are buried in the muscular layer, if necessary. Usually superficial sutures are all that are required. In all operations for the removal of these deeper-lying growths if possible the orbital plate should be left in situ.

The other tumors found in the nose and naso-pharynx are more infrequent.

**Angiomata.**—Rare, largely in males, the chief symptom being the epistaxis, which is profuse and persistent.

**Adenomata.**—Seen usually in connection with a hypertrophic condition of the surrounding tissues, and when not complicated with carcinomata are not a serious affection. Like the other tumors in this region they should be removed with the ecraseur or thermo-cautery loop.

**Exostoses and Osteomata.**—Uncommon, symptoms resemble those of other obstructive tumors of the nasal passages with the exception that there is an unusual hardness and rigidity. Where of long standing these bony tumors sometimes ulcerate and necrose, and this necrosis may encroach on normal bony structures, thereby making a more serious complication. They vary in shape and size but are usually easily separated from their points of attachment.

**TREATMENT.** Their removal can sometimes be accomplished by the help of the ecraseur or stout bone scissors, or occasionally an intra-nasal saw. From time to time they are so formed or are so large that they require Langenbeck's or Rogue's operation. The use of the dental engine may sometimes be of service in breaking a large tumor into pieces so that it can be taken away through the natural passages.

**Enchondromata.**—Even more rare than osteomata. Their diagnosis and treatment will hardly vary from that of osteomata.

**Carcinomata.**—Rarely involve the mucous surfaces of the nose or throat, primarily. They may go there by metastases or the gradual encroachment of tissue. The history and age of the patient will easily afford the diagnosis.

**Sarcomata.**—More frequently complicate fibromata or myxo-fibromata. The treatment of these malignant tumors is early and thorough extirpation. The tendency to the infection of contiguous tissues and involvement of the glands in the neighborhood renders the operations for their removal much less satisfactory, as far as permanent relief is concerned, than the benign group.

## CHAPTER IV.

### INJURIES AND DISEASES OF THE SINUSES.

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**Maxillary Sinus.**—The antrum of Highmore is particularly liable to injury, due to its exposed position. The outer wall may be fractured by a blow. Compound fracture, with perforation of the antrum, is not uncommon. These injuries may be unaccompanied by inflammation, and, again, there may be, as the result, inflammation of the mucous membrane and consequent abscess. Inflammation may also be the result of the inflammation of the mucous membrane lining the nose or following up the roots of the teeth. Hematoma may be formed in the antrum, especially where the nostrils are occluded. The efforts at clearing them may force blood through the normal aperture from the nose into the antrum. This blood may be absorbed in time, but often remains as a source of irritation and aids in the formation of abscess. Whether abscess be the result of traumatism, the extension of severe inflammation from the nose, from alveolar periostitis the result of dental caries, or degeneration of an hematoma, the symptoms are similar. Unless the communication between the nose and antrum is occluded the symptoms of pressure are not very great. There is local pain, radiating in different directions, and superficial edema. There is usually a discharge of pus into the nostrils and the patient complains of a disagreeable taste in the throat and mouth, especially on waking in the morning. This is particularly noticeable if the patient sleeps on the side opposite to that of the affected antrum. The pus is usually fetid and unless suffering from ozena, where the sense of smell is somewhat lost, the patient will notice it. In rare cases, where the opening into the nose is closed, the pus tends to accumulate and produces distension of the antrum with absorption of the bony walls. This may occasion displacement of the eyeball, expansion of the whole jaw, followed by spontaneous perforation in some direction, if relief is not given. In these cases of distension the pain is very severe, of a neuralgic and intermittent character. Percussion will reveal a dull sound over the affected antrum. An electric lamp introduced into the mouth shows semi-translucence of the normal antrum; the affected one is dark.

Differential diagnosis between abscess or cystic degeneration, or tumor of the antrum, is sometimes very difficult. The discharge of pus will form the basis for a diagnosis, but sometimes an exploratory incision through the alveolar process is necessary for confirmation. The cachexia accompanying malignant growths is wanting in abscesses or cysts.

**TREATMENT.** For the inflammation, previous to pus formation, general antiphlogistic measures should be resorted to. Relief of any obstruction between the nose and antrum is sometimes accomplished by the inhalation of hot, medicated vapors, hot applications externally and the ordinary antiphlogistic medication. Should pus form, free opening

should be made as soon as possible. Where the abscess is due to traumatism, thorough drainage through the wound, or if there is no wound externally, perforation of the antrum at a point at the root of the second bicuspid, about an inch above the border of the gum, should be made, the mucous membrane being incised and the bone perforated with a trochar or bone drill. If the abscess is due to the involvement of the the antrum from periostitis, in connection with caries of the tooth, the same procedure should be instituted, unless the tooth is so carious as to be useless, in which case it should be drawn and if the consequent opening into the antrum is insufficient for drainage the bone drill should be used for the purpose of enlargement.

Either of these methods will usually suffice for drainage.

If the fetor be extreme, however, a counter opening should be made into the nostril and a small drainage tube can be drawn from the mouth into the nose and left in position for a few days. This treatment and thorough irrigation hastens the reparative process. Daily irrigation should be practiced, or more frequently in case the fetor is such as to demand it. After a few days have passed the drainage tube can be withdrawn but both openings should be kept patulous by a small packing of iodoform-gauze. Irrigation with a warm calendula or Thiersch's solution or Condy's fluid is advisable. Should there be extreme fetor a few irrigations with bichloride solution, not exceeding one to four thousand, followed by the use of a considerable quantity of sterilized water, can be tried.

If the opening is through the alveolus there is a tendency for the food to be forced through at this point. This sometimes requires the use of artificial denture during mastication. With the best of care these abscesses are frequently slow in healing and go on to necrosis of some of the bones surrounding them.

**Tumors of the Antrum.**—These are not uncommon. A considerable percentage of them are malignant. Carcinomata may originate in the antrum itself or invade it secondarily. They are usually characterized by excessively rapid growth.

**SYMPTOMS.** These are at first scarcely noticeable. Some obstruction of the nostril will occur, but until the tumor fills the antrum and commences to expand there are no characteristic symptoms. Expansion of the cheek is rapid, with stretching and thinning of the skin which often becomes involved and ulcerates superficially. This gives exit to a watery, fetid discharge and often the protrusion of a fungus-like growth.

The nose and orbit rapidly become involved and the growth may find its way into the several fossæ. Glandular involvement is not characteristically shown until the disease is fairly advanced, but the rapid growth and cancerous cachexia, which is soon developed, will assist in the diagnosis. Carcinomata seldom appear before forty. Next in frequency are sarcomata or sarcomatous degeneration of fibromata. These are malignant tumors of early years or middle youth, of rapid growth, increasing with their malignancy. Sarcomata are not as liable to affect the skin as are carcinomata, but the deformity due to encroachment on the fossæ and other sinuses is very rapid. Non-malignant myxo-fibromata may occur. Osteomata and enchondromata may form in the antrum.

**TREATMENT.** As soon as a tumor in this location is recognized, the



question of operation should be decided. If age and general health permit and there is absence of signs of involvement of inoperable parts prompt operation of the most radical character should be performed.

Virtually the operation consists in the removal of the upper jaw.

If the trouble is malignant the removal of suspicious tissue should be carried as far as possible. If the tumor is benign the incision should be made as if a resection of the entire maxilla were to be done and the antrum opened by resecting its anterior wall. Polypi or fibromata or other non-malignant growths can be rapidly excised.

**RESECTION OF THE UPPER JAW.** For tumors of the antrum this operation is best performed as follows: A straight incision through the median line of the lip and prolonged on one side of the columna nasi into the nostril of the affected side will permit of the soft tissues being dissected from the jaw so as to completely expose the anterior wall of the antrum.

This may then be perforated and the anterior wall removed with bone forceps or a very fine straight saw so as to permit of the removal of the tumor within. In case the growth has affected the bone and tissues surrounding the same incision through the skin and soft parts is continued around the alæ of the nose, alongside of the nose and over the infra-orbital ridge or near the canthus to the malar bone. This will permit of further dissection of the soft tissues and a more complete exposure of the bone. In this way a large part of the jaw or the entire jaw can be cut away with the bone forceps or small saw which can be carried horizontally from the nostril at any desirable level and so as to preserve the palatine plate. This method has the very great advantage of preserving the facial nerve and dividing only small branches of the facial artery. The division of the bone would be required at three points, the palate, the nasal process of the maxilla and the malar bone. This can be done with the bone forceps or the saw. Where the division of the whole jaw is necessary a narrow saw is introduced into the nostril and the hard palate is divided with the alveolus, after the extraction of the central incisor tooth. The nasal process of the maxilla, which may be sawn through partially or completely, and the malar bone are next sawn or cut through parallel to and immediately in front of the masseter muscle. If the malar bone is not affected it is best to leave it, that the general contour of the face be maintained; but if involved it is necessary to remove it by dividing the zygomatic process and the frontal process at its juncture with the frontal bone.

Before prying up the bone the soft palate should be divided transversely close to its attachment to the hard palate. These cuts, made with the saw, should be thoroughly smoothed with a pair of bone forceps, and then using the bone forceps as a lever, the whole jaw can be tilted forward and permit of the introduction of the knife to cut the infra-orbital nerve and also any soft tissues which may remain attached to the jaw. The hemorrhage in this operation, although profuse for the time being, is readily checked. If there is difficulty in the use of the hemostatic forceps where the oozing is principally from the blood vessels of the bone the cautery should be applied at double red heat. Careful examination should be made to see that all diseased tissue is removed and the flap of skin is then carefully brought into place and fixed with sutures.

The lip is best kept in position by the use of hare-lip pins and the sutures should be numerous and of fine material. If there is persistent oozing it is better to fill up the cheek and pack the opening with iodoform-gauze or sterilized gauze soaked in a saturated solution of iodoform-ether. Irrigation, after removal of the packing, should be frequent enough to keep the discharge sweet.

**Frontal Sinuses — Distension.**—Such distension occurs usually as the result of injury, in some cases immediately following injury, and in others not appearing for months or even years. There may be inflammation, acute, usually going on to suppuration, or chronic, frequently of tubercular or syphilitic origin. There may be simple distension from the retention of the normal secretion from the frontal cells, caused by the blocking up of the infundibulum, the opening into the nose. This stoppage of the infundibulum may also be the result of inflammation of high grade in the mucous membrane, as, for example, erysipelas. The distension is more frequently chronic, the fluid collecting for some length of time. In these cases there is usually no decomposition of the fluid and it slowly distends the sinus and displaces the eye. Sometimes the chronic distension will have acute or sub-acute inflammation associated. The symptoms of distension in the chronic form may be gradual formation of tumor at the upper and inner portion of the orbit, and a slow but steadily increasing protrusion of the eye upward, outward and forward. There is scarcely any pain and often only a sense of weight over the brow. In the acute variety there is dull, aching pain over the brow and root of the nose, accompanied by constitutional febrile disturbance. There are symptoms of acute coryza, swelling coming on rapidly and tenderness with a feeling of weight. If the pus is of any considerable quantity the bone is gradually thinned so that a sense of fluctuation may be imparted on palpation. In acute cases there may be delirium and if pus is accumulating rapidly, without relief, it may perforate the posterior plate and meningeal pressure-symptoms supervene.

If the inflammatory process is the result of tuberculosis, caries or necrosis of the bone, it is quite manifest. If of syphilitic origin there are usually constitutional symptoms and the history of the case to confirm the diagnosis. Where distension of the frontal sinus is caused by the accumulation of pus it is sometimes called empyema of the frontal sinus. In cases of empyema there may be spontaneous evacuation into the nose, orbit or ethmoidal cells.

**TREATMENT.** The treatment is immediate evacuation as soon as there is any appreciable distension, and the establishment of free drainage into the nose. A single curved incision is made parallel with the fold above the lid on the most prominent part of the tumor. The soft parts are retracted and the bone perforated with a small bone drill or scalpel and contents evacuated. The opening should then be enlarged for a thorough exploration of the sinus, using either the finger tip or a probe. Any carious or necrotic bone should be removed and then an attempt made to secure a counter-opening into the nose; by carrying the little finger up the corresponding nostril the point can be made out where the tip of the finger in the nose will approximate the end of the finger in the sinus. At the part where the fingers come more nearly together there is but a thin plate of bone. The finger is then withdrawn and the gauge or drill is



passed into the sinus and through the lower bone on which the finger in the nostril is resting. This being accomplished an india rubber drainage tube is to be introduced, one end passing through the external wound and the other coming through the nostril. The drainage tube can be most easily introduced by a probe pierced with an eye, which can be threaded and the drainage tube being fastened on the end of the thread, thus carrying it through from the sinus into the nose. The external incision can be stitched together up to the drainage tube. Irrigation of the sinus is usually necessary for a number of weeks, or until the discharge has ceased. Carbolic acid, boric acid solution, calendula solution or some astringent, should be used.

In the very chronic cases the entire anterior wall may have to be resected.

**Tumors of the Frontal Sinus.**—Comprehended in tumors which originate in the frontal or ethmoidal cells and those growths which originate in the nose, antrum or adjacent localities and afterward extend into the frontal sinus. Of the first class the most frequent are exostoses and osteomata. Myoxma and fibroma occasionally occur. Rarely sarcoma and carcinoma. Where the tumors cause distension and symptoms of pressure in different directions, they may require removal. Where the osteoma or exostosis is connected by a small pedicle with the adjacent bone it can be removed with impunity, but where the attachment to the bone is very extensive it is impossible to separate it without danger of opening into the dura. Other varieties of tumors may be removed by a modification of the operation called for in empyema, provided their attachments and involvement of surrounding tissues are not too extensive.

**Injuries of the Frontal Sinus.**—Fractures are occasionally produced by blows in the face or stab wounds. A compound fracture may make an opening into the sinus which is quite obvious. In simple fracture emphysema of the forehead and of the face is a frequent symptom. If the posterior wall is injured and the dura exposed operation is sometimes necessary. Fistulous openings sometimes result in compound fractures, through which the air may pass from the nose and which may require a plastic operation. Injuries followed by depression of the outer table may require incision and elevation to prevent deformity. Foreign bodies are sometimes found in the frontal sinus, introduced by parasites or consisting of detached osteomata or necrosed bone.

The ethmoidal cells are liable to disease, by direct extension from the mucous membrane of the nose. Polypoid growths, caries and adenoid and hypertrophic changes may occur.

**Sphenoidal Sinus.**—This is often affected by extension of disease from the mucous membrane of the nose, as in affections of the ethmoidal cells. Empyema of this cavity is the result of this extension from the Schneiderian membrane. The symptoms are headache, spasmodic or sympathetic affection of the nerves in close relation, especially photophobia and blepharo-spasm. Caries and necrosis of the body of the sphenoid bone may occur, sometimes associated with thrombosis of the cavernous sinus, retro-pharyngeal abscess and perforation of the base of the skull. Fractures involving the sphenoidal sinus usually show an escape of the cerebro-spinal fluid. For relief of the distension the sphenoidal cells may be reached through the naso-pharynx, through the orbit, after



enucleation of the eye, and through the nose, which last route is usually selected. Tumors of about the same character as those described in the discussion of the frontal sinus may be removed, although much more difficult of accomplishment.

**Inflammation of the Schneiderian Membrane.**—Of interest surgically when it is the result of injury or causes inflammation and supuration in some of the contiguous processes in the different sinuses. The acute variety, of surgical origin, does not vary in its symptoms and course from that of so-called "cold in the head." It may be caused by irritating vapors, exposure to cold or wet, by involvement of the mucous membrane, from acute disease of the skin, as well as surgical causes such as foreign bodies, traumatism, tumors, periostitis, cellulitis or carbuncle.

**SYMPTOMS.** Of whatever origin, its symptoms are a profuse discharge of mucus, unusual susceptibility and irritation of the Schneiderian membrane, producing sneezing and tickling on the slightest provocation, and swelling of the membrane which may cause partial or total obstruction of the nasal passages. The quality of the voice is modified by the obstruction, as well as the induration of tissues in the naso-pharynx. The naso-pharynx is usually affected in the same way so that the openings into the Eustachian tubes are rendered less patulous and there results greater or less deafness. The sense of smell may be more or less dulled. If the inflammation extends to the mucous membrane of the sinuses there is considerable frontal headache and pain in the upper part of the face. Later the mucous discharge becomes mixed with pus, until finally it consists almost entirely of pus. An ordinary case will run its course in from five to six days. The symptoms and duration can be modified to a very great extent by treatment.

**TREATMENT.** The inhalation of steam, the water being medicated with camphor, hamamelis or benzoin, will often afford considerable relief. This can be done by a vaporizer or a pitcher or suitable vessel with a cover made of paper to concentrate the steam and carry it to the nose and mouth. These inhalations of steam should not be resorted to where the patient is out and about. Solutions of cocaine, sprayed into the nostrils, give a deal of temporary relief, but the reaction from their continued use tends rather to produce a chronic congestion of the parts. The use of a nasal douche is occasionally of value, but care should be taken that permanent trouble of the Eustachian tubes is not caused by it. The insufflation into the nostrils or throat of powders of different kinds may occasionally be of value.

**MEDICATION.** In homeopathic remedies there are several of great value. *Nux vomica* is of especial service when taken at the very incipency of the attack. *Arsenicum album*, *gelsemium*, *belladonna*, *cepa*, *mercurius*, *kali* and many others are also indicated in special cases. Repeated attacks of acute coryza often tend to the production of hypertrophic and atrophic catarrh.

CHAPTER V.  
CATARRH, SEPTUM DEVIATIONS, EPISTAXIS,  
RHINOPLASTY.

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**Catarrh—General Considerations.**—The disease, which is originally a simple congestion of the mucosa, gradually involves the deeper structures. The mucous glands become affected so that there is hypersecretion and also a deposit of connective tissue surrounding the glands which makes the entire mucosa thicker, and this, combined with hypertrophy of the glands, makes a tissue that is adenoid in character, that easily absorbs moisture from the atmosphere and becomes correspondingly enlarged or semi-erectile, so that any slight irritation of a foreign body or of fumes will cause swelling. Anything which causes congestion, such as stimulants or very stimulating or highly-seasoned food, will cause a noticeable diminution in the calibre of the nasal passages. The discharge is usually excessive, of a muco-purulent character and it sometimes becomes fetid where portions of the tissue ulcerate and cause superficial sloughs. Sometimes a recumbent posture will cause enough added congestion to complete the obstruction, so that the patient is inclined to breathe through the mouth at night, or be unable to lie down. This adenoid tissue can also form in the naso-pharynx, and may cause a greater or less impairment of hearing by its pressure around the orifice of the Eustachian tubes. If this process is uninterruptedly continued there is a final destruction of the glandular elements of the mucosa and sub-mucosa, so that there is following this the so-called atrophic catarrh.

**Atrophic Catarrh.**—Obstruction of respiration is not so marked as the dryness of the parts, which generally causes discomfort in breathing. There is apt to be a pronounced fetor of the discharges, as the collections of pus and mucus are thrown off from the membrane so slowly as to cause them to dry, and there are formations of crusts and plugs under which there may be more or less superficial ulceration. Besides the ulceration mentioned in catarrhal conditions there may be ulceration of tubercular (lupus), syphilitic, leprous or malignant origin.

Ulcerations of mechanical origin are inclined to be more active for the evident reason that the folds of mucous surface are brought in close contact, as, for example, that which might be caused by a deflection of the septum or growths of any kind impinging on the lumen of the canal. These ulcerations may occur in any point of the mucous membrane, but their most frequent site is the septum.

**OZENA.** This term is usually applied to an offensive discharge and may be caused by any one of these conditions mentioned, which causes a localized decomposition of the discharge or superficial shreds of tissue. It is more pronounced where the ulceration has gone so deeply as to cause caries or necrosis of bone, or where the disease may have originally

started as a necrosis, with subsequent ulceration of the mucous membrane.

**DIAGNOSIS.** The diagnosis of the different forms of ulceration will depend on the history. If tubercular it is usually accompanied by symptoms of other localized tubercular lesions which will readily assist in the diagnosis. Syphilis has its confirmatory symptoms. Leprous ulceration does not occur independently of other characteristic manifestations. Malignant ulcers occur only as a part of the history of a malignant neoplasm. If the ulceration is due to or accompanied by necrosis of bone or caries it is usually diagnosed by the aid of a probe.

**TREATMENT.** The properly chosen homeopathic remedies are of material assistance in the treatment of any and all forms. There is a wide field for both medical and surgical treatment. Where the hypertrophic condition has gone on to the formation of large masses very thorough removal, by different methods, will materially aid the efforts at relief. This can be done by chemical applications, such as caustics, or the actual cautery, or they can be removed by properly constructed forceps or scissors, which adapt themselves to the different curves in the form of the passages and growth. Small crushing forceps and scissors can be used to remove the masses; or if there is a great tendency to hemorrhage it is best to remove with a wire *ecraseur*, the modified Jarvis being one of the best; or they may be removed by the galvano-cautery loop. Illumination and the use of the rhinoscope should always accompany these operations. Local anesthesia, such as is accomplished by an application of ten per cent. solution of cocaine, is usually sufficient. Where the extirpation is accomplished by the use of chemical agents there is often more resulting pain and inflammation than where it is done as above described. Chromic acid is used and the galvano-cautery knife or point is applied in the same way. The resulting sloughs separate in a few days and the cicatricial contraction shows itself in the course of a few weeks. Whatever methods are used for extirpation after-treatment is required. All fetor should be kept down by the use of antiseptic sprays or douches and the general health and tone of the patient should be improved to the utmost. Especial care should be taken to avoid attacks of acute coryza. Where there is ulceration it should be treated according to its cause. In tubercular ulcerations, caries or necrosis is expected and their products should be removed. Usually it can be done through the natural passages, after which the parts should be brought as nearly as possible to a normal condition and invigorating constitutional treatment be given. If of syphilitic origin the specific remedies should be vigorously pushed. All carious or necrosed bone should be removed and an attempt made to keep the parts free from fetor by sprays or douches. Where the ulceration is due to malignancy the growths should be removed if possible and the mucous membrane treated as in ordinary ulcer.

One of the conspicuous causes of catarrhal ulceration is found in septal deviations. Sometimes it is impossible to fracture the septum without previously weakening it in some way. This can be done by stellate forceps or by punching it in several places with the punch forceps, Fig. 516, thereby weakening the septum to such an extent that it can be broken. The nasal saw can be used to weaken the bone, but it offers the same objection as the punch, which leaves a space in the bone that occasionally does not fill in.



Incision may be made at the long axis of the deviation and then the fracture can be completed by the pressure of the fingers or forceps. After fracture of the septum and moulding of the parts into proper position they can be held in place by packing the nostrils with gauze or by the use of pins which are forced through the skin at different angles so that they will act as a sort of splint. This obviates the necessity for packing, but requires the greatest cleanliness and care to avoid a disfiguring ulceration of the skin around the pins. These cases require prolonged post-operative treatment to prevent recurring deformity, and the mucous membrane should be kept in as healthy a state as possible until the repair of the cartilage and bone is complete.

**Deviations of the Septum.**—These are the most common malformations of the nose, a large per cent. of all septi having deviations to a greater or less extent. Flexions of the cartilaginous portion are most common, and deviations of the bone are next in frequency, the entire septum comparatively rarely so. Where the deviation is of slight extent and makes only an irregularity in the passage it does not usually give any discomfort, except when it is associated with a chronic hypertrophic condition, or when the mucous membrane is so thickened that it causes pressure against the side of the nose. Again, with only a slight deviation there may be hypertrophy of the turbinated bone, which causes obstruction. Where the deviation is of such extent that there is constant contact between it and the inferior and middle turbinated bones this may, in itself, be the aggravating cause of a chronic catarrhal condition.

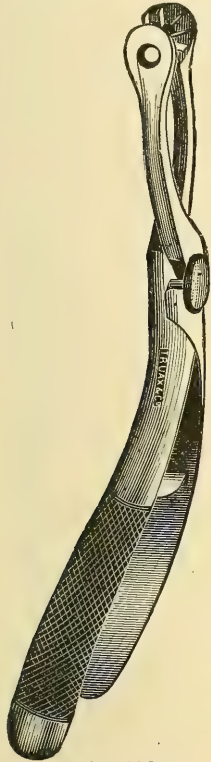


Fig. 516.  
Jarvis Model,  
Steele's Septum Punch

**OPERATIVE TREATMENT.** Operations for the correction of deformity might be called for in many cases. Forceful fracture of the septum by properly constructed forceps may be employed, and then the septum held in its normal position until healed as described above.

**Epistaxis.**—Coincident with the history of any of the diseases of the nasal passages which have been mentioned, there may be a greater or less degree of bleeding. Of itself this does not usually require surgical treatment, but occasionally in connection with constitutional disease, or disease of the Schneiderian membrane, there seems to be an especial tendency towards hemorrhage. It may be the result of injury, ulceration, or degeneration of the mucous membrane of blood vessels. It is frequent in full-blooded children and adults, and may be caused by change from dense to rarified air, or vice versa. It may be a symptom independent of these causes, in some acute disease, such as typhoid fever, purpura or chlorosis; or suppression of menses; or may be vicarious from hemorrhage in varicose conditions or malignant tumors. The ages of puberty and pregnancy seem to favor it. It may vary from an extreme degree, as a few drops to an amount which endangers life, and may

escape from one or both nostrils, or drop into the pharynx and be swallowed and show itself in the vomiting.

**TREATMENT.** The venous circulation should be assisted as much as possible by loosening tight clothing and by position. Keeping the head high is advisable unless otherwise indicated by an inclination to syncope. Efforts to dislodge the clots formed should be guarded against. Elevation and extension of the arms above the head, pressure at the root of the nose or on the cheeks near the nose, seem to be helpful in causing contraction of the nasal blood vessels. The application of cold at the back of the neck may also aid in arresting the hemorrhage. Astringent nasal douches, such as alum or hamamelis, as well as the introduction of very hot or cold water or ice and the local application of ten per cent. solution of antipyrine will sometimes check the hemorrhage. When it is very severe time should not be lost in attempts at temporary measures of this character, but plugging of the nasal passages should be resorted to. The introduction of packing through the anterior nares may be sufficient, but if this does not arrest the bleeding the posterior nares may have to be occluded. This can be best accomplished with the aid of Bellocq's canula, (Fig. 517), which is introduced through the anterior nares and passed along the floor of the nose into the pharynx, when the spring-like trochar is forced out and appears in the pharynx. A loop of silk or string is passed through the eye of the canula, which is then withdrawn, and to this string the packing or pledget is attached. There should be a string attached to the plug, and this left outside of the mouth so that the packing can easily be withdrawn. Or the packing or pledget can be introduced by the help of a silk or flexible catheter which is threaded and can be passed through the nose. As it impinges on the posterior wall of the pharynx it is forced downward.



Fig. 517.  
Bellocq's Canula.

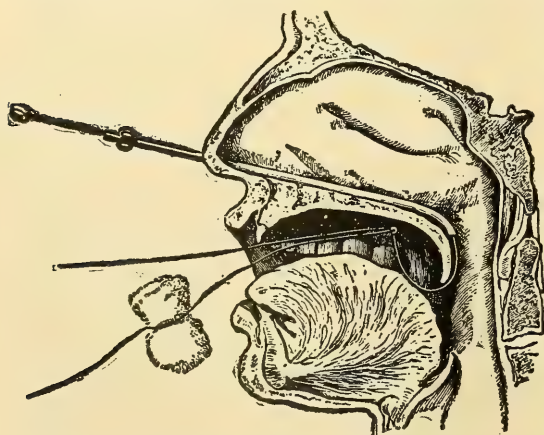


Fig. 518. Method of Plugging Posterior Nares by Bellocq's Canula.

methods constitutional medication should be instituted to correct the

The loop can then be caught by a pair of forceps and brought forward and the operation completed, as with a Bellocq's canula. After this the anterior nares should also be plugged. These plugs should not be left in place more than forty-eight hours. The plugs inserted in the anterior nares should always have a string or piece of silk attached so that they can be easily removed. They should not be left in position until there is fetor. After control of the epistaxis by these methods constitutional medication should be instituted to correct the



tendency. Hamamelis is of great service, both locally and internally where the hemorrhage is of a dark, venous character. Ipecac, belladonna, secale or nitric acid may be indicated.

**Rhinoplasty.**—This operation includes all operations for the restoration and repair of the nose, for congenital deformities, the repair of defects and injuries and the repair of the ravages of disease, which may be accompanied by caries or necrosis of the bone or simple destruction of the soft parts. Restoration of parts of the nose, lost or injured from disease, or even of the entire organ may be attempted. When the deformity is due to excess of tissue rhinoplasty may be employed to remove superabundant tissue, and allows of a nice adjustment of the flaps or replacement of the lost tissue by that taken from the cheek. Complete rhinoplasty is usually done with the pedicle carrying a vascular supply, and left in position until the communication has been established on the tissues covered by the flap. The sliding of flaps taken from the cheeks or unaffected portions of the nose may accomplish the necessary covering, and the consequent denuding of tissue may be filled in with Thiersch skin-grafting. With any of these procedures it is necessary to have absolutely healthy tissues to work upon, and all diseased or unhealthy tissues should be very carefully removed prior to the operation. Fistulous openings on one or both sides of the nose can be covered by sliding or transplanting flaps from adjacent cheeks, but care should be taken to excise ulcerated or cicatricial margins.

In an extreme condition of “pug-nose” the efforts of rhinoplasty are directed toward raising and approximating the two wings of the nose, after a vertical incision, or to cutting transversely across the nose and drawing the tip down into position. Transplantation from the cheeks fills in the defect. The columnæ nasi can be made by taking a flap from the upper lips in the middle line, and then turning the strip upward and freshening the tip of the nose for the reception of the end of the flap. When but one ala of the nose is destroyed the flap is usually taken from the opposite side. Where the end of the nose has been destroyed the flap can be taken from the forehead and turned downward, with the skin surface directed toward the nasal cavity. Subsequent Thiersch skin-grafting can be performed on the outside of the flap, or the flap can be carried down from the bridge of the nose and the mucous lining be formed by a flap taken from the mucous membrane of the nose. All of these procedures tax the ingenuity of the surgeon, in the nicety required for the adjustment of the flaps and the delicacy required in the application of the sutures. In all these operations, as well as those for complete rhinoplasty, allowance should be made for contraction of the flaps. There will be a gradual shrinkage not only along the edges, but throughout the entire flap, so that the flaps will often give the appearance of superabundant tissue for a few weeks or months, but will finally shrink to the desired size.

For entire rhinoplasty there are three quite distinct methods. One where the flaps are taken from adjacent tissue, the Indian method, the osteoplastic or forehead method, and where they are taken from the arm, the Tagliacotian or Italian method. (See Plastic Surgery.)



## CHAPTER VI.

### WOUNDS AND INJURIES OF THE LARYNX.

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**General Considerations.**—Wounds and injuries of the larynx may be internal or external; from the introduction of foreign bodies into the air passages or from different kinds of wounds from without; from contusions and, again, from wounds from suicidal or homicidal attempts. The more frequent forms of cut-throat are usually directly in front where the great vessels are not necessarily divided. The wound may go deeply into the larynx, severing the epiglottis or even going into the posterior wall of the pharynx without being fatal. The atomizing of the blood by an opening into the air passage usually makes a severe looking and threatening injury.

Treatment in the majority of cases consists in stopping the hemorrhage, thoroughly cleaning and approximating the tissues, using buried suture of sheep-gut where portions of the larynx have been severed, and sewing the skin with sheep-gut, silk, or whatever may be chosen. Feeding may be difficult or impossible, requiring the use of the stomach tube or rectal nutritive enemata for a few days.

**Punctured and Gun-Shot Wounds.**—Punctured and gun-shot wounds of the larynx may occur. Wounds of the internal structure usually result from the introduction of foreign bodies, such as fish-bones, buttons, needles, pieces of glass, etc., and may be of varying size and severity according to the exciting cause. The introduction of these foreign bodies may excite immediate laryngeal obstruction and may necessitate immediate tracheotomy, or even kill the patient before anything can be done. If possible the foreign body should be located and at once removed, as it will be hidden by the edema or swelling of the parts later on. Where this swelling has already occurred it may have to be reduced by local treatment before the foreign body can be discovered. The laryngoscope is here of great service. Again, a foreign body may be located by the tracheal tube. Low tracheotomy may be resorted to and the extraction of the foreign body accomplished through the tracheotomy opening, or pushed up through the larynx from below.

**Fractures of the Larynx.**—Fractures of the larynx are recorded. They occur more frequently where there have been senile deposits of earthy salts. Cases are on record where they have been caused from the blow of a fist. The symptoms vary with the severity of the injury and its cause; pain, dyspnea and cough, usually accompanied by vomiting of bloody mucus and frequently loss of voice or pain on using the voice. Pain on swallowing is a frequent symptom, accompanied by emphysema and edema of the larynx, sometimes going on to fatal issue.

**TREATMENT.** Tracheotomy should be performed. Perfect rest to the parts and coaptation by nicely adjusted compresses, with local medication, should be secured. A judicious selection of the homeopathic

remedy will be found to assist materially in relieving the symptoms in such cases.

**Foreign Bodies in the Larynx and Trachea.**—The entrance of a foreign body into the larynx and trachea is of common occurrence. It is usually immediately expelled by a reflex attack of coughing. Expulsion may be aided by hanging the patient head downward and giving a quick, severe slap on the back. The substances finding entrance may be artificial teeth, vomited matter or particles from the nasopharynx, and various kinds of objects from without, such as pieces of cork, sponge, toys, buttons, etc. Foreign bodies are more likely to be lodged at the epiglottis, whence they may pass down and become fastened at the bronchus, or higher in the trachea. Sometimes a smaller article or substance may cause a greater amount of irritation. Where the substance is organic it may slowly absorb moisture and gradually increase in size. Or it may become encysted and not give further trouble. The symptoms are usually cough, spasm of the larynx and dyspnea. These may be of variable severity, from absolute asphyxia to chronic laryngeal symptoms, such as accompany an ulcer or abscess. The prognosis should be guarded, even if the immediate symptoms are not grave.

**TREATMENT.** Except where the emergency is so great as to demand immediate tracheotomy efforts should be made to expel the foreign body by inverting the patient and sharply slapping the back or chest. Many times this is successful. If the foreign body is large it will usually lodge

within reach of the finger, and, with the mouth open to the fullest extent possible, the finger should be carried down to the epiglottis and swept around the rim of the larynx in the attempt to dislodge the object. Pushing the larynx up from without sometimes enables the finger to be introduced still deeper. The laryngeal mirror may be used and the foreign body removed by means of forceps of different kinds. (Figs. 519, 520). Where the exigencies are not great repeated laryngoscopic examinations should be made, and later, after the parts are more accustomed to the mirror and manipulation, the object may be seen and extracted. It should be borne in mind that oftentimes the patient

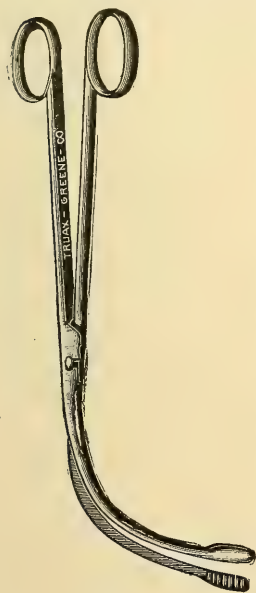


Fig. 519.  
Fauvel's Laryngeal  
Forceps.

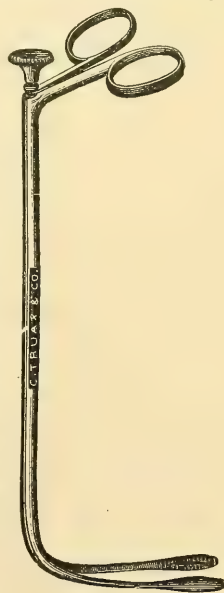


Fig. 520.  
Waxham's Burgess  
Forceps.

thinks he feels the presence of the foreign body even after its removal, the irritation from the wound or temporary presence of the substance making such impressions remain after the expulsion of the body itself. This is especially liable to occur in nervous, hysterical patients.

**Burns and Scalds.**—Burns and scalds of the larynx and trachea may accompany injuries to the esophagus and pharynx. Burns may be caused by inhalations of hot steam, flame or superheated air, and scalds may be caused by hot water or caustic liquids. The attempt to swallow caustic fluid is usually accompanied by the introduction of some of it into the larynx. The symptoms from these injuries are usually violent and immediate and resemble those given in the description of edema of the larynx. Tracheotomy should be thought of, although it may be of only temporary relief. Aside from tracheotomy antiseptic sprays, mouth washes, gargles, mucilaginous and rice drinks, rectal nourishment and anodynes are essential. Homeopathic remedies are of great service.

Apis is especially valuable for general swellings and edema. Throat livid, uvula edematous; lips and buccal walls enormously distended and livid.

Cantharis helps where the pain is excruciating, and the mucous membrane is burned to shreds, fairly cooked and blistered.

Urtica urens is very like cantharis, vesication of throat and buccal membrane.

Causticum is applicable where the mouth and throat are scalded deeply, the tissues being cooked, shriveled and separated in folds.

Bromium and hepar are applicable for the suppuration that follows mouth and throat burns. Iodine and other remedies may be called for. Belladonna will often allay the pain and swelling, and aconite will control the inflammation and fever following upon injuries of this character. Calendula or hamamelis, as mouth washes, are very useful.



## CHAPTER VII.

# SURGICAL DISEASES OF THE LARYNX AND TRACHEA.

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**Definitive Considerations.**—There may be congenital deformities and defects in the non-development of one or more of the laryngeal cartilages, or an unusually small size of the entire larynx. Incomplete closure between the different parts also occurs so that their function is impaired.

Fissures or fistulæ are sometimes seen, being usually defects in the normal closure during fetal life, and fissure of the epiglottis is sometimes seen also. These fistulæ may occur as low as the trachea.

The symptoms of these fissures are a mucous or muco-purulent discharge of a few drops, combined with air bubbles, on forced expiration.

The treatment consists mainly in the stimulation of the margins of these fistulæ by caustics, or their occlusion by a plastic operation.

**Trachelocele.**—This is a hernial protrusion of the mucous membrane of the trachea between two rings or through a congenital cleft. It is most common in the adult male.

**SYMPTOMS.** These are indicated in a unilateral tumor which may vary in size from one-fourth of an inch to two or three inches in diameter. Rarely it is bi-lateral. It dilates on forced expiration, with the mouth and nose closed. There is dyspnea, and the quality of voice is altered, or there may be an entire absence of voice.

**TREATMENT.** This may be palliative. Pressure should be kept up for some time by some object covered with suitable wadding for protection and pushed down on the tumor, and held in position by adhesive plaster, bandages or other retentive measures. Radical treatment consists in excision.

**Laryngitis.**—This may be simple, idiopathic or of traumatic origin, acute or chronic. It may be due to diphtheritic or erysipelatous infection and metastasis, tuberculosis or syphilis. It becomes a surgical disease only as it demands operative interference. As the result of these different forms there may be laryngeal edema.

**Edema of the Larynx.**—This is an infiltration of the serum or fluid portions of the blood into the connective tissue underlying the mucous membrane of the larynx, or any portion of the contiguous mucous membrane. It may develop rapidly, endangering life and demanding operative interference immediately; or it may be chronic in its progress and not be sufficient of itself to absolutely obstruct the air, but may make the passage so narrow that an unusual accumulation of mucus or pus on the mucous surface may serve to entirely obstruct respiration. Edema may follow wounds of the larynx, and of the neck when the larynx has not been implicated, even where traumatic inflammation has not progressed sufficiently far to cause general edema from the lack of free circulation.

**SYMPTOMS.** These usually come on quickly. Local distress, which may amount to excessive pain, is present, together with dyspnea, especially in inspiration and violent and impulsive attacks of coughing. These symptoms, accompanied by aphonia, produce great mental anxiety. The redness of the face may approach lividity, or even become cyanotic, and protrusion of the eyeballs and weak, flickering, feeble pulse may supervene.

**PROGNOSIS.** The prognosis must depend upon the cause or accompanying disease. The immediate danger is that of asphyxiation. If this is obviated the exciting cause may be relieved by other measures.

**TREATMENT.** In cases not too acute multiple punctures into the edematous tissues, using a curved bistoury with a short-cutting edge and point may possibly give relief, this being done with the aid of the laryngoscopic illumination. Hemorrhage into the larynx should be avoided, if possible, but free bleeding of the puffy tissues should be encouraged by inhalations of steam or gargling with warm water. A repetition of these punctures may be required every few hours.

Should the case prove too acute for these measures intubation or tracheotomy should be resorted to. Tracheotomy will always be the favorite operation from the fact that it can be performed with simple, easily procured instruments, the ordinary equipment of the household furnishing a sufficient quota in cases of extreme emergency. Intubation, as now practiced with improved instruments, is an operation which will commend itself where there is time for the procuring of the instruments.

Homeopathic remedies properly selected save many cases from operation and even where operation is demanded should be given afterwards. Arsenicum album, aconite, spongia, causticum, bromium, iodine, hepar sulphur, sapo, mercurius, the kalis and many others might be indicated.

Arsenicum will be called for when there is burning pain in the larynx, increased by the effort of swallowing, with sensation as if the tissues were swollen at the root of the tongue. There is prostration, nausea, and short, dry, hoarse cough occurring in paroxysms.

Spongia meets hoarse, whistling, croupy respiration as from spasms of the larynx, the larynx being so swollen as to almost protrude above the chin. Sensation as if a plug were in the throat, with pains in the larynx when touching it or turning the neck.

Causticum is indicated especially when there is aphonia from the edema. The patient cannot articulate at all.

Bromium applies especially where suffocation from edema occurs. The voice is hoarse and husky, and there is a raw, scraped feeling in the throat.

Hepar meets the sensation as of a clot of mucus in the throat interfering with the swallowing, with stitches extending to the ears. It has also hoarse, rough, barking cough and absence of voice, with slight suffocative spasms.

Kali bichromicum covers the condition of edema of the larynx with secretion of long strings of tough mucus, and a saw-board roughness of voice.

Aconite, mercurius, iodine, cepa and other remedies may occasionally be useful.

**Abscess of the Larynx.**—Abscess of the larynx may arise from the inner lining of the larynx, its tissues or cartilages, or may be the tissues behind the larynx. It is usually a secondary trouble and results perhaps most frequently from diseases of the cartilages. It may be the result of a phlegmonous or traumatic laryngitis, or tubercular or syphilitic involvement of the larynx. It may be from glanders, smallpox or pyemia.

The local symptoms are constant pain, pain on the use of the voice, on swallowing and coughing, and dyspnea. There may be symptoms resembling those of edema. A laryngoscope will aid in confirming the diagnosis. Spontaneous rupture of the abscess usually occurs, but the symptoms of suffocation may be so acute as to demand surgical interference.

**TREATMENT.** Incision with bistoury as in edema should be practiced. Where time is afforded this may be the best surgical treatment, but preliminary tracheotomy may also be demanded from the severity and acuteness of the symptoms.

**Stricture or Stenosis of the Larynx.**—Stenosis or stricture may be caused by affections of the larynx itself or from disease of tissues without or above the larynx. Stenosis from outside the larynx may be the result of abscesses, tumors or enlargements of the thyroid, thymus, or other glands of the neck, or from aneurisms or cicatrices. Stenosis from the larynx itself may be caused by congenital defects, foreign bodies, tumors, contractions from ulcerations, or paralysis from the spasmodic action of muscles. The stenosis may be at any point and may vary to extreme limits. Varying with its causes stenosis may be permanent or temporary.

The symptoms are dyspnea, increased during inspiration or exertion, accompanying anxiety and cyanotic countenance, pulse small and frequent, and excessive muscular efforts to breathe. Aside from the relief of the immediate danger from suffocation the general treatment would depend upon its cause, syphilis and tuberculosis always being taken into consideration as a possible cause where there is doubt in diagnosis, and constitutional treatment being directed accordingly.

**Tumors of the Larynx.**—When confined to the larynx proper and not demanding tracheotomy these belong rather to the sphere of the specialist. Where they have involved the peri-laryngeal tissues to such an extent as to endanger life their extirpation devolves upon the general surgeon. Papillomata, fibromata, angiomatica, enchondromata and cysts often cause irritation and inflammation of the larynx sufficiently to threaten suffocation, without any involvement of the surrounding tissue.

The malignant tumors would be sarcomata and carcinomata, or sarcomatous and carcinomatous degeneration of other tumors; sarcomata attacking tissues rapidly, as a rule in young subjects; carcinomata growing either slowly or rapidly in subjects from forty to fifty years of age.

**DIAGNOSIS.** As in that of any growth impinging on the calibre of the larynx, diagnosis is materially assisted by laryngoscopic examination.

**TREATMENT.** When the tumors are small they may be taken out through the natural passage. This would be largely in the sphere of the specialist. Some growths, however, can be removed only by opening the larynx.



## CHAPTER VIII.

### OPERATIVE MEASURES.

**Tracheotomy.**—This term, tracheotomy, is used to cover any surgical opening in the respiratory tract from the thyroid cartilage to the sternum, including, of course, laryngotomy (thyrotomy), an opening through the crico-thyroid membrane; laryngo-tracheotomy, where both larynx and trachea are opened; and the opening of the trachea proper.

The operation as hereinafter described is the best and the one referred to wherever the term is used. There are two situations where the trachea is more readily reached, one above and one below the isthmus of the thyroid gland. The latter location is usually chosen as there is more room. In urgent cases, however, the isthmus can be incised and hemorrhage controlled by forceps or ligatures, but it is better not to injure it.

This operation, simple in the best of circumstances, may, from the fact that it is performed at moments of almost extreme suffocation and the fact that it is often done without anesthetics, become one of the most difficult of operations. Where careful dissection can be done there is hardly any need of hemorrhage, but where the work has to be

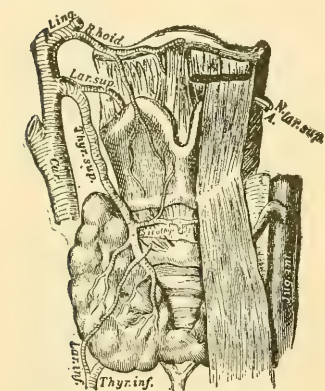


Fig. 521. Blood Supply of the Larynx and Trachea (Esmarch and Kowalzig).

done rapidly there is often hemorrhage from a number of veins and arteries which gives considerable trouble. The blood vessels are usually overcharged from threatened asphyxia and consequently occupy more space than in the normal state. The application of hemostatic forceps where there is no anesthetic is accompanied by pain and adds to the struggles of the patient. In young children the thyroid gland, rising half an inch above the sternum as late as the sixth or seventh year, may be in the line of the incision, so that as a general statement the higher the incision the better. The head and neck should be put upon the stretch and carried well backward and the anesthetic given in this pose. The use of cocaine or freezing of the skin in the line of incision would certainly be advisable where a general anesthetic cannot be used. Incision should be made in the median line and be carried from the cricoid cartilage from one to two and a half inches downward.

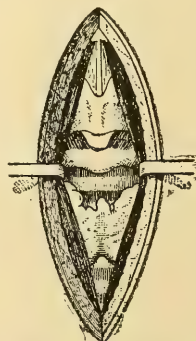


Fig. 522. Parts Exposed in Tracheotomy (Esmarch and Kowalzig).

The knife should be used only for incision of the skin and final division of the tracheal rings. The muscles and fasciæ should be loosened and pushed aside with a dissector or the handle of the scalpel. In this way most of the blood vessels can be avoided until the cartilaginous rings are seen. After these are thoroughly exposed all hemorrhage is checked. The trachea is steadied by a sharp hook and the scalpel introduced between the rings. The rings are incised quickly, two or three being divided, or but one ring and the cricoid cartilage, according to the case. Dressing-forceps, or a regular tracheal dilator should be carefully introduced immediately following the introduction of the knife, and by spreading these apart the calibre of the opening is increased, the act being usually accompanied by the dislodgment of any mucus. The incision in the trachea should usually be about an inch in length. If the operation is performed for a foreign body in the trachea or membrane it should be searched for and extracted by proper forceps, preceding the introduction of the tracheal tubes. The insertion of a suture through the trachea on either side of the wound is advisable whenever there is no tracheotomy tube at hand, or when the presence of the tracheal tube causes an excessive amount of irritation. In this way the opening can be enlarged by pulling apart the ligatures, and if necessary these may be carried around the back of the neck and tied, the wound and tracheal opening being thus kept patulous. The moment the opening is made the rush of air causes violent coughing, and exaggeration of the respiratory motion is apt to draw blood into the wound. This excites added coughing and usually dislodges any mucus or membrane. This may be violently forced through the opening and expelled, so that great care should be taken to prevent inoculation of assistants or operator by diphtheritic or malignant discharge. Often at the critical moment of incision, or immediately following, the patient will suffer collapse, and prompt measures are required to re-establish respiration, as artificial respiration, the suspension of the patient by the heels and slapping him on the back to dislodge the mucus or obstructive body.

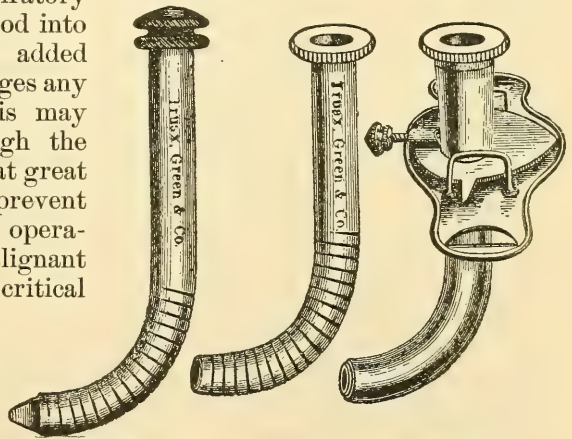


Fig. 523. Tracheotomy Tube with Probe-Pointed Inner Tube.

Usually the first introduction of the tracheal tube is also followed by a paroxysm of coughing, but by keeping the tube clean and free from mucus this will gradually cease. The best tubes are made of silver or aluminum, the latter being preferable on account of its lightness and lesser tendency to cause irritation. These should be constructed with an inner and an outer tube, so that the inner tube can be taken out and cleansed whenever necessary. The outer tube should have a flat flange through which straps can be passed around the back of the neck. (Fig. 523.)

As ordinarily designed the tracheal tube precludes the passage of air through the upper portion of the trachea and mouth. This is obviated by a modification of the ordinary tube, by Keen (Fig. 525), in which there is an opening left in the tubes so that air may pass through the upper portions. There may be an obstruction from mucus or crusts or membrane which cannot be relieved by taking out the inner tube. In this case the introduction of a probe, wire brush or probang, either through the outer tube, or by taking both tubes out, may dislodge the obstruction; but the removal of the outer tube should be done only when absolutely

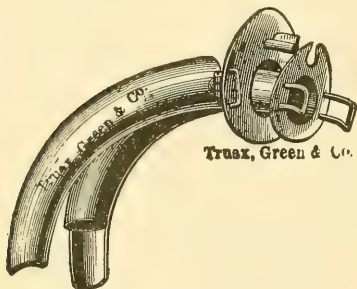


Fig. 524.  
Guendron's Split Canula.

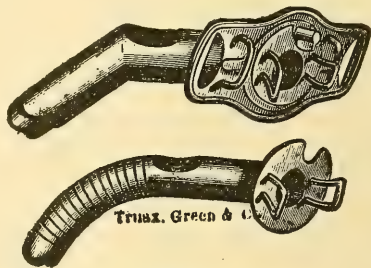


Fig. 525.  
Keen's Trachea Tube.

necessary, as there is sometimes great trouble in its re-introduction. Inasmuch as the air is not warmed by its passage through the nostrils or pharynx the air in the room should be unusually warm, being kept at a temperature of about 80 degrees Fahrenheit and also kept moist by steam. Stimulants are frequently indicated and the homeopathic remedies which may have been tried without success before the operation should be persisted in. The length of time the tubes should remain in position will depend upon the causes for operation. If for removal of a foreign body from the trachea it can be safely removed at the end of from two to three days. If for croup or diphtheria it should not be removed until after the tendency to the formation of membrane is overcome. If for relief of stenosis or ulceration of the larynx it may have to be worn for months or years. Where used for palliative treatment in cases of malignant diseases it should be permanent. The greatest care should be exercised in keeping the parts clean. Frequent change in the dressings should be made, especially after suppuration has set in.

**OPERATIVE DANGERS.** The greatest dangers and complications of the operation are syncope, pneumonia or broncho-pneumonia, sloughing around the wound, emphysema and cellulitis, secondary hemorrhage, progressive ulceration, the formation of abscesses in the cervical tissues and the possibility of the burrowing of the abscess down the neck into the mediastinum. All these dangers are lessened by strict enforcement of the suggestions in regard to cleanliness.

Syncope is to be expected most frequently in old, feeble people or where the operation has been too long postponed. It is to be combated by lowering the head and by the use of cardiac stimulants, such as inhalations of nitrate of amyl and of ether, where it has not been used as an anesthetic.

Broncho-pneumonia is to be feared, especially in diphtheritic cases.



If not developed by the fourth day it is not to be apprehended. Emphysema may be caused by an insufficiently long skin incision at the time of the operation or later by a valve-like closure from the fact that the skin and tracheal openings do not correspond. It occasionally requires multiple punctures. Sloughing around the wound and cellulitis more frequently occur where the dissection or the effort at the introduction of the tube has bruised the tissues. Secondary hemorrhage is rare but often serious. Ulceration occurs most frequently when the tube is not of right curve, size, or not in good position.

Cleanliness and delicate manipulation in the change of dressings and tubes lessen the chances of abscess formation.

**Intubation of the Larynx.**—Intubation has been brought to its present state of perfection by O'Dwyer. It may take the place of tracheotomy in many cases. It requires a set of tubes of various sizes

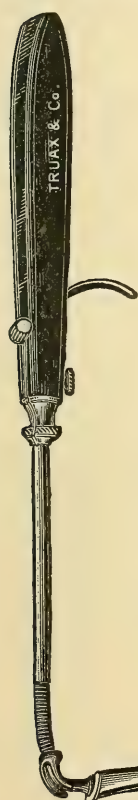


Fig. 527. O'Dwyer's Scale for Measuring Tubes.

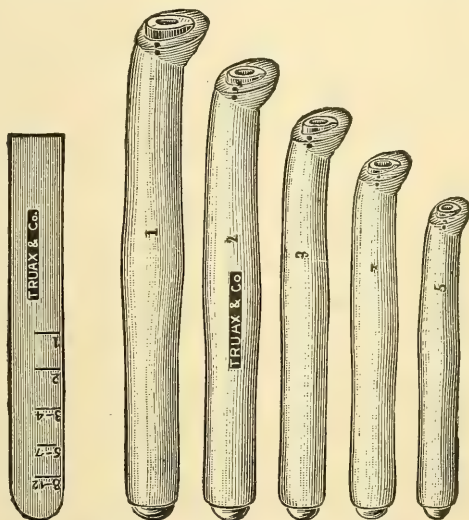


Fig. 528. Set of Tubes.

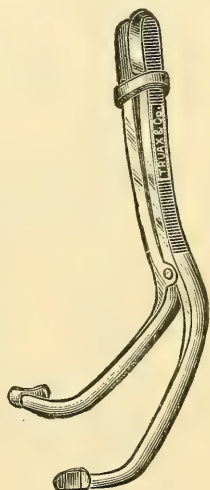


Fig. 529. Mouth Gag.

Fig. 526. Tube on Handle.

(Fig. 528), which conform to the shape and size of the larynx at different ages, and obturators of different sizes, which are screwed into a handle. (Fig. 526). There are small holes in the tubes through which loops of silk are passed so that they can be removed in case of misplacements. A gag (Fig. 529) is used and the mouth forced open and held to its greatest possible limit. The arms and feet of the patient are held by wrapping them in a blanket. The operator and assistant stand in front. The operator introduces his finger, locates the tip of the epiglottis, which he raises, and at the same time introduces the tube on the handle. (Fig. 526). The lower end of the tube is forced into the larynx, the finger acting as a guide. The handle is then raised and the introduction accomplished as quickly as possible. The instant the tube is in position, which is noted by the finger being passed over into the esophagus, it should be dislodged as quickly as possible from the obturator by pushing the slide on the handle. Practice will render

the technique of this operation so perfect that this introduction can be accomplished in a few seconds. The gag should be left in and a firm hold maintained on the patient until the first suffocating effects of the operation have passed away. After a short breathing spell the finger should be again introduced to make sure that the tube is in position, and the silk cut and quickly removed from its attachment.

The gag is then withdrawn and the patient allowed freedom. Occasionally there is such violent coughing as to dislodge the tube. As it is usually accompanied by the dislodgment of membrane which temporarily relieves the exigency of the case it is best to re-introduce the tube and use a size larger. The stoppage of the tube by membrane sometimes occurs. Occasionally the tube is swallowed, but this never gives serious trouble. While the tube is in position the patient loses his voice. There is also difficulty in deglutition from choking, and this should be overcome as much as possible by feeding in small quantities at a time, so that even should the food enter the trachea it will not cause any serious irritation. The taking of food when the patient has his head lower than his body materially assists in swallowing. Food that is excessively cold, such as ice cream, or other foods frozen to the consistency of ice cream, is sometimes more easily swallowed. While the tube is in position the air of the room should be kept warm and moist as in tracheotomy. The removal of the tube has frequently to be accompanied by a maneuver similar to that of its insertion. The gag is used in the same way, the extractor, so called (Fig. 530), is introduced, and is guided into the opening in the tube by the finger, which also fixes the epiglottis. The spring of the extractor is now firmly compressed, which forces apart the blades at the tip, thus acting as a hook, when the tube is easily withdrawn. The after-treatment is somewhat similar to that of tracheotomy. The properly indicated homeopathic remedies should be given, with stimulants and nutritious food, and the patient should be kept on his back as much as possible, to avoid syncope.

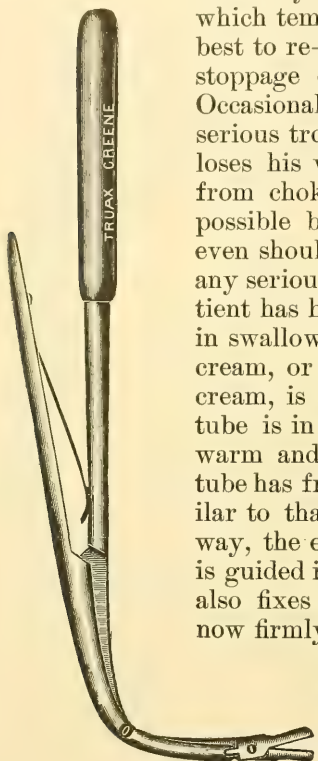


Fig. 530.  
O'Dwyer's Extractor.

**Thyrotomy or Thyroid-Laryngotomy.**—This operation consists in incising and splitting the thyroid cartilages and exploring the interior of the larynx.

The cutting of one or more of the tracheal rings, which may be united, gives a larger field of operation and usually the introduction of a tracheotomy tube by carrying the incision through the first or second tracheal rings materially assists in healing the wound in the larynx. In the treatment of malignant growths it is useless to remove the simple tumor in the larynx; it usually requires the removal of a portion of the larynx proper and the tissues surrounding it, or even the removal of the entire larynx.

**Laryngectomy.**—Extirpation or resection of the larynx is of course justifiable only as an extreme measure. The chances of permanent

relief are increased if there is no involvement of tissue surrounding the larynx, but even with this involvement there are cases where there has been temporary relief lasting for months or even years. Being so often thought of as only a dernier resort, the majority of cases have been operated upon when the cachexia was general and the constitutional debility advanced. This certainly adds to the gravity of the prognosis. Where the operation is performed before there is general constitutional involvement the prognosis is more favorable. Where time is of no importance preliminary tracheotomy should be performed one to three weeks in advance, giving time for the relief of the lung or tracheal irritation which may be caused by that operation. If preliminary tracheotomy has been performed the anesthetic is best administered through a tracheotomy tube and the trachea plugged above the tracheal opening.

(The Trendelenberg tampon and canula is one of the best. Fig. 531. The sub-cutaneous incision should be a long one, in the median line, from the symphysis of the chin to the upper end of the sternum. The parts should be carefully dissected, all involved tissues being separated and lifted up by the dissector, avoiding the use of the knife as far as possible. All hemorrhage should be temporarily stopped by hemostatic forceps, a ligature being only occasionally necessary. As the incision is made through the isthmus of the thyroid especial care should be taken in regard to hemorrhage at this point. The first tracheal ring and larynx are separated in front and on the sides. The first ring of the trachea is then freed from the esophagus and the larynx may be gradually freed from below or from above; but care should be used at this stage of the operation to prevent the blood's trickling down into the trachea. Where preliminary tracheotomy has not been performed this is the most critical point of the operation. The free use of the hemostatic forceps as a temporary measure to stop the hemorrhage and the rapid dissection of the larynx and tissues involved are best, leaving the application of ligatures until after the removal of the outside mass. It is also best to introduce into the trachea, after the incision, a tracheal tube and packing around the tube with gauze, and thus prevent the blood's running down the trachea. After removal of the larynx all hemorrhage should be checked, and then any portions of the infected tissues or ramifications of tissues affected in the surrounding parts should be carefully dissected out. The anterior wall of the esophagus will usually be involved in the operation, so that care should be used in putting in the dressings, that in case of vomiting the entire dressing need not necessarily be changed. The opening above the trachea tube, when it is in place, and the wound proper should be firmly packed with

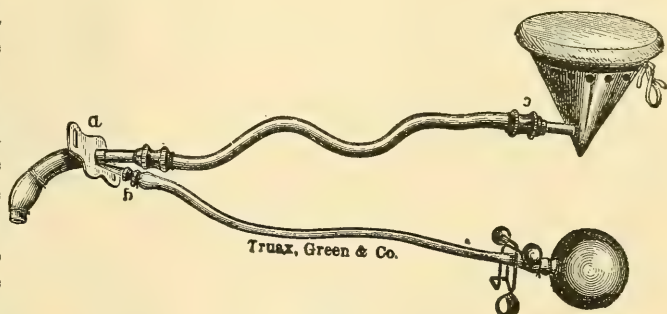


Fig. 531.  
Trendelenberg Tampon.



iodoform gauze or other antiseptic gauze. Iodoform, however, seems to act best in keeping the dressings sweet where they are liable to be moistened with the food or vomited matter. The dressings should not be changed except as required from wetting or becoming foul.

**DIET.** For the first few days the patient should be nourished by nutritive enemata. When the danger from vomiting is passed he should be fed through the stomach tube. Peptonized milk, eggs and broth are recommended, the stomach tube being either left in position or introduced at each time of feeding. In two or three weeks the granulations may have closed the wound to such an extent that the stomach tube will have to be introduced through the mouth. Cicatrization soon follows, which tends to contract the wound and opening into the trachea. To counteract this the introduction of an artificial larynx (Fig. 532) or combination of trachea tubes is necessary. The different modifications of the artificial larynx have so improved the instrument that quite a tone is now produced. The use of a tampon into the upper part of the tube, to be used during deglutition, is at first necessary, but after wearing the apparatus some weeks the patient will not have to continue its use and can swallow without any choking.

**PARTIAL LARYNGECTOMY.**—When involving only one-half the larynx laryngectomy is performed in the same way as in complete excision. This operation is more difficult. The tabulated records have a greater percentage of recoveries, which is undoubtedly due to the lesser involvement of the tissues, and not necessarily to the operation's being any less severe.

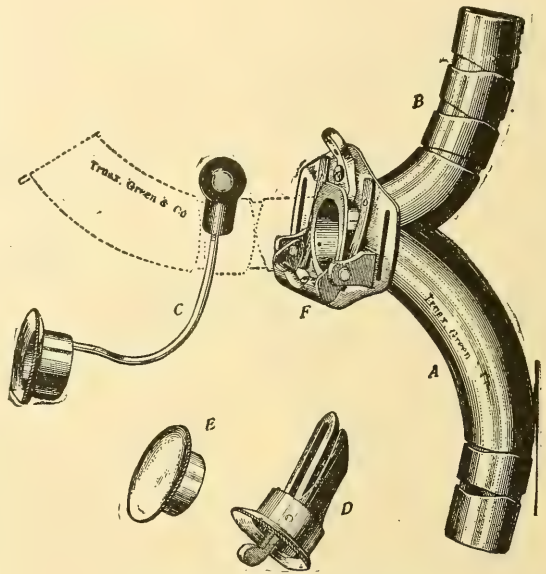


Fig. 532. Artificial Larynx.

## CHAPTER IX.

### SURGICAL DISEASES OF THE CHEST.

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**Hydrothorax.**—Pleuritic effusions may be caused by pleuritis, acute or chronic, pneumonia, with or without pleurisy, tuberculosis, tumors of the pleura, lungs, walls of thorax or mediastinum, and foreign bodies. They may be the result of extreme rachitic deformities of the chest, scoliosis or Pott's disease. A large proportion of the cases with which we have to deal are the result of pleurisy, in connection with traumatism, contusions of the chest wall, fractures of the ribs, or penetrating wounds of the chest.

**Hemothorax.**—A collection of blood in the pleural cavity may also be of traumatic origin, namely, from a fracture of the ribs or penetrating wounds of the chest. Rarely it may occur without traumatism, as in tubercular degenerations and diseases of arteries. The blood may be from an intercostal blood vessel or from the pleura itself, or may come from the lung in the case of deeper wounds.

**Empyema.**—This term may be used for a collection of pus in any normal cavity of the body, but where not specified is commonly understood to refer to a collection of pus in the pleura. The pus in this cavity may be the result of the same causes that bring about serous effusions with the accompanying infection through the microbes of suppuration. The infection may be produced through the systemic circulation or directly through wounds, if there be such. In the vast majority of cases it is the result of chronic processes, there being first a simple effusion which later on becomes pus. Coincident with the formation of pus the pleura becomes thickened and altered, often with deposits of fibrin on the surface. Where the original pleurisy is caused by tuberculosis there may be pus, the result of the action of the pus microbes, and with these germs may be found the tubercle bacilli. Again, in connection with pneumonia the diplococcus pneumoniae may be present. Metastases from burns usually cause rapid suppuration in the pleural cavity.

**Diagnosis.**—The signs of fluid in the pleura are the same, whether the fluid be serum, blood, or pus. The patient assumes the position that will afford the sound lung the most freedom; that is, he leans or lies toward the affected side. There is usually a limitation of motion of the side affected. The intercostal spaces may bulge or be on a level with the surface of the ribs. However, this bulging is more marked in empyema than in hydrothorax. The apex of the heart, too, may be displaced to one side or the other if the quantity of fluid present be large. The liver may be displaced outward. On palpation there is no friction. There is dullness on percussion and absence of respiratory and vocal sounds over the area occupied by the fluid. The area of dullness also varies with a change of position of the patient where the amount of fluid is not excessive, the dullness being higher at the back when lying. On the sound side there is usually an exaggerated resonance. Again, in empyema, the

subcutaneous tissues may be slightly edematous. The presence of fever, with or without chills, especially if the fever is continued for several weeks, would strongly indicate the probability of empyema. A positive diagnosis may be made by the use of the needle of a hypodermic syringe or an aspirator. Hemothorax, if of any great extent, is also accompanied by anemia or signs of hemorrhage.

**Prognosis.**—In hydrothorax this depends on its cause, and is usually favorable if from an uncomplicated or simple effusion. The prognosis in hemothorax would also depend entirely on its cause. If from a fractured rib or penetrating wound that can be kept aseptic, it is usually favorable. The prognosis in empyema is favorable if the result of a simple uncomplicated pleuritis and subject to early, radical treatment. It is more favorable in children than in adults, and in recent than in old cases. Empyema the result of tubercular processes is usually fatal. In long-standing empyema the lung may become collapsed from compression and firm adhesions, resulting in a physical condition which renders definite healing difficult, if not impossible.

**Treatment.**—Hydrothorax will sometimes yield to internal medication, where the discomfort is not so great as to demand immediate relief.

The principal remedies indicated are: Arsenicum album, bryonia, carbo vegetabilis, ipecac, kali carbonicum, lycopodium, pulsatilla and sulphur.

**Operative Treatment.**—If after a judicious trial of the properly indicated remedies the disease is not arrested, immediate recourse should be had to aspiration, paracentesis, thoracis or thoracocentesis.

An anesthetic is not always required. The patient is best kept in a semi-recumbent position, but care should be taken that the withdrawal of

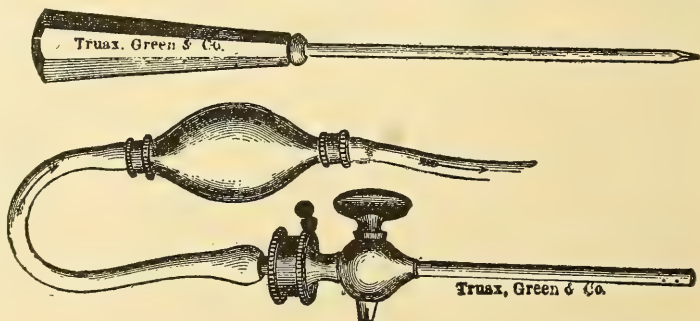


Fig. 533.  
Aspirator Trochar.

the fluid does not bring on syncope. If syncope should threaten, the patient's head should be lowered. The strictest antiseptic precautions should be used. The aspirating needle should lie for a long time in an antiseptic solution, or, better still, be sterilized in water with bicarbonate of soda or liquor potassæ. The best points at which to aspirate are either the intercostal space just below the lower angle of the scapula or just in front of the latissimus dorsi muscle, passing the aspirating needle in at the upper border of the rib. In its introduction the needle should be guarded with the thumb so that it will enter only the pleura. The quantity of fluid withdrawn will vary, according to circumstances. Should the discharge become bloody as it emerges from the aspirating needle the needle should be at once withdrawn. An attempt to empty the pleural cavity completely should not be made. If a violent paroxysm of coughing is



induced the needle should be partially withdrawn, as there is danger of laceration of the pulmonary pleura.

**HEMOTHORAX.** The treatment of hemothorax will consist in arresting the hemorrhage, if it still continues, and the removal of the blood, if in large quantities. This can be accomplished by aspiration or resection of the rib.

**EMPHYEMA.** The treatment of empyema will consist, in some cases, in the removal of the pus by aspiration. But the majority of cases require drainage and cleansing of the pleural cavity by some antiseptic fluid. By aspiration the surgeon determines absolutely the presence of pus and relieves the symptoms of pressure. But often it is only preliminary to the radical operation, by which is meant incision and drainage. Whichever operation is performed first should be done with the strictest antiseptic precautions. Nothing but antiseptic material should be used. The aspirating needle should be carried in a direction corresponding to the center of the intercostal space, therefore in an oblique direction, from below upward. Unless a different locality is better indicated, by a tendency to point in some position, the intercostal space, just below the lower angle of the scapula, at the back, or at the side, just in front of the latissimus dorsi muscle, is to be preferred.

Care should be taken to avoid the application of too much suction force, as it is easy to draw in a portion of the pleura or shreds of fibrin.

The sudden expansion of a compressed lung sometimes produces syncope, and a change of the position of the heart from withdrawal of the fluid may also cause it, so that a recumbent position or stopping of the aspiration may be necessary, for the time. Should aspiration not accomplish what is wished, in permanent relief, recourse should be had to thoracotomy.

**THORACOTOMY.** This consists of a simple incision, about two inches long, through the skin, over the intercostal space, the incision into the pleura being from one inch to a half inch shorter. In opening the pleura care should be exercised not to push the knife too far in. If there is no indication of the empyema perforating the chest wall, and appearing as a subcutaneous abscess, the best point in which to make free incision is at the side, just in front of the latissimus dorsi muscle, not lower than the eighth interspace, and even as high as the sixth. This gives the advantage of gravity in the drainage, there is less discomfort from the drainage tubes and the pleura is nearer the surface. Frequently the space between the ribs is so small that resection of the rib is necessary, usually that of the seventh, about an inch to an inch and a half in length. The periosteum is reflected with an elevator and also separated posteriorly from the rib. By keeping it in close contact with the bone there is no danger of injuring the intercostal vessels. The rib is raised with the elevator and with a pair of heavy bone forceps or a chain saw the section is removed. The pleura, which is usually dense and bulging, can then be incised. Irrigation of the pleural cavity immediately after the operation is not necessary if no putrefaction is present, which shows itself by fetor. It is also contra-indicated if there is a bronchial fistula. If, however, fetor is present the cavity should be thoroughly irrigated with a solution of bichloride of mercury, one to 5,000, or a saturated boric solution, always followed by a quantity of sterilized warm water.

The drainage is usually good in a rib resection. The best drain is a fenestrated rubber tube, about three-eighths of an inch in diameter, or, better still, two tubes stitched together. These tubes should be from four to six inches long, and should be secured externally by a large safety pin, or by being passed through a disc of stout rubber, three or four inches square, the tube being slit on three sides and the branches secured to the face of the disc with sutures, as it is very easy for drainage tubes to be lost in the pleural cavity. (Fig 534). It is seldom necessary to make a counter opening. After complete evacuation of the pus or irrigation fluids, a large quantity of antiseptic and absorbent dressing should be placed over the wound, and over this an air-tight dressing, such as rubber tissue, mackintosh or starched or crinoline bandages. A daily changing of the dressings and antiseptic irrigation will be necessary in fetid empyema, if the first disinfection has not proved successful in making the pus sweet. Where the irrigation has to be repeated one of the best injections is a solution of calendula officinalis (succus calendula or the non-alcoholic extract), one part to eight of sterilized water. In ordinary cases it is not necessary to remove the dressings until saturated with the discharge, or unless the temperature indicates the retention of septic material. However, should evidences of putrefaction or sepsis develop the antiseptic irrigations are again indicated. Care should always be taken to have the irrigating fluid warm, about blood heat. As soon as the discharge has become serous and has diminished to a small amount one of the drainage tubes may be made smaller or removed entirely, as when the discharge is no greater in quantity than that which would be caused by the presence of the tube.

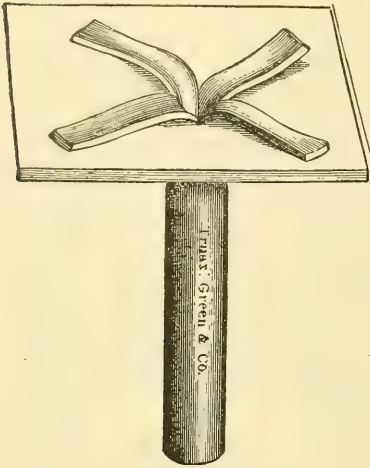


Fig. 534.

Drainage Tube and Rubber Disc.

**THORACOPLASTY.** Multiple resection of the ribs may be called for where there is only partial expansion of the lung, or the pleural cavity cannot collapse because of the unyielding thoracic wall.

**ESTLANDER'S OPERATION.** This operation consists in removing sections of from one-half to two or even three inches in length of all the ribs up to the compressed lung, sometimes two or three of the ribs sufficing, and, again, other cases requiring the resection of six or eight ribs. (Fig. 535).

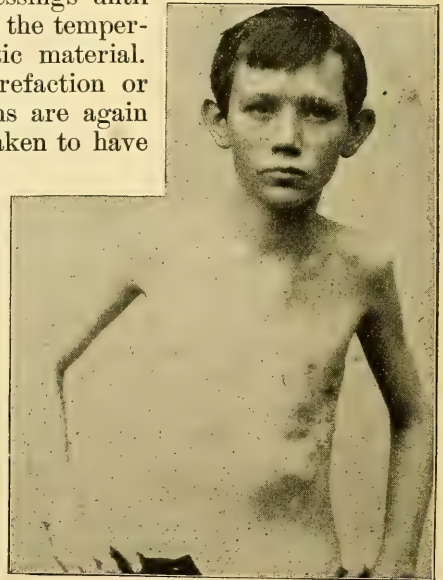


Fig. 535.

Estlander's Operation.

There may be cases where, in order to produce collapse of the abscess cavity, another line of incision through the ribs may be necessary, in front or behind. If need be the abscess cavity is curetted. Drainage tubes, if used after this operation, should be gradually shortened at each dressing. The wound should be dressed openly and if the drainage tubes are not used the cavity may be packed with iodoform gauze. As granulations spring up in the healing abscess-cavity from the bottom the compressed lung is drawn downward with them so that considerable restoration of function may be secured. In obstinate cases where even Estlander's operation has failed Schade advises an operation which consists in the entire resection of the thoracic wall over the cavity. A skin flap is made with its base upward, and after removal of the ribs the wall is covered with it. The flap is not sutured but is kept in position by a compress of gauze. This operation, although most radical, sometimes has to be resorted to.

The properly selected homeopathic remedy is of material assistance in the recovery of those cases demanding operation. *Calcarea carbonica*, *calcarea fluorica*, *calcarea iodata*, *calcarea phosphorica*, and *silicia* may be indicated.

**Intrathoracic Tumors.**—These may have their origin either in the thoracic wall or viscera of the thorax. *Enchondromata* or *osteomata*, involving several ribs or the sternum or costal cartilages, occur as large masses pressing into the pleural cavity and against the viscera, sometimes with a pedicle. *Sarcomata*, or sarcomatous degeneration of other tumors, may develop in this way, and more rarely *carcinomata*. Primary carcinoma may develop in the pleura and pericardium, and secondarily involve the lung, and metastatic carcinoma may occur in the mediastinum. Metastases of sarcoma may occur in the lungs or heart. Hydatid tumors or masses of actinomycosis form in the lung. Lymphadenoma occurs primarily and with leukemia in the mediastinum. Aneurysmal tumors occur in the thorax. Teratoma has been found in the mediastinum. Perforation of echinococcus cysts of the liver sometimes occurs into the pleura, and may even involve the lungs.

**DIAGNOSIS.** This can be made only by a careful study of the physical signs. Microscopical examination of the sputum may assist. A diagnosis by exclusion and by symptoms of pressure upon certain nerves and vessels can be made. Aspiration might assist the diagnosis, the fluid containing hooklets, if hydatid.

**TREATMENT.** Tumors of the walls of the thorax are often cases for operation. The character, extent and adhesions would of course determine the possibility. Where they involve a few ribs or the sternum these can be resected. If any healthy periosteum is found in making these resections it is well to save it. Where the operation involves the opening of the pleural cavity, with consequent collapsing of the lung, the dangers should be appreciated by the patient and his friends. A modification of Estlander's or Schade's operations has given good results in cases which a few years ago would have been considered as inoperable. If the skin is involved to any great extent recourse may be had to a flap operation, in which the incisions are carried to a considerable distance into healthy skin and a flap is dissected up and slipped over the affected area, with



broad attachments at one side. The denuded portion of healthy, subcutaneous tissue usually heals by granulation, and rapidly. If for any reason this is not practical a Thiersch skin-grafting operation is to be thought of as an expedient. Tumors involving the contents of the thorax seldom justify operative measures.

**Hydatid Tumors.**—Masses of actinomycosis involving a portion of the lung might call for operation. Tumors of the lung may be excised where the location of the tumor permits, the necessary resection of ribs being better done at the back. Two or three ribs should be resected at first for positive diagnosis, and if after the exact location is determined the operation is continued, resection of more ribs will probably be necessary to give sufficient working space. The tumor should then be removed by the thermo-cautery. Ample drainage is required and frequent dressings at first.

**Lung Abscess.**—This may be the result of the suppuration of a circumscribed portion of lung tissue or may develop after a general attack of pneumonia or gangrene of the lung. It may also be the result of tubercular processes. With modern advance in surgery abscesses may now be classified as cases justifying radical operation. The diagnosis would depend upon the history of the case. If following an attack of pneumonia there is fever, after the ordinary run of the fever of the disease, and localized dullness, lung abscess may be suspected. Absolute diagnosis, however, requires exploration with the needle. By means of percussion and auscultation the point of the abscess nearest the surface is located, where the lung is explored with an aspirating needle of small size and at least four inches long, attached to a hypodermic or aspirating syringe. The needle is pushed through the intercostal space in the direction of the center of the suspected area and if it enters the abscess cavity it is marked by some loss of resistance. Suction is then applied and if pus be found the diagnosis is confirmed. If at the first attempt no pus be found the needle should be pushed forward, and at different stages suction be applied. The needle may be withdrawn partly and pushed in another direction, and in this way considerable masses of lung tissue be thoroughly explored without great danger. The exact location of the pus must be first determined by exploring before operation on the lung is justified. Section of at least one or two ribs is made at the seat of exploration, and as a general thing the lung will be found adherent to the parietal pleura. If this is not the case it is best to defer further incision until the adhesion of the lung to the pleura is caused by tamponing. When the adhesions make it safe the operation is carried on by re-locating the abscess with an exploring needle and then incising the lung with a cautery point, the needle being left in as a guide. Troublesome hemorrhage is obviated by use of the actual cautery, and an opening is made which is lined throughout with a protecting barrier against any infection from the suppuration of the lung tissue. As large a drainage tube as can be used in the opening made by the cautery is used. If there are no bronchial fistulæ the abscess cavity is irrigated with an antiseptic solution or a calendula solution. If, however, bronchial fistulæ exist it is best to sterilize the abscess cavity as far as possible with some dry powder, such as iodoform and boracic acid, one part to eight. The after-

treatment of these abscesses is the same as the after-drainage for empyema. Where a tubercular abscess is being dealt with it is better to exsect the abscess wall; only, of course, in cases where there is comparative certainty that there are not other abscesses. The technique would be the same as in the removal of tumors of the lung, the incision being made by a thermo-cautery knife or point into healthy tissue.

## CHAPTER X. INJURIES OF THE CHEST.

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**Contusions.**—Slight contusions may cause ecchymoses and some rupture of muscle with no consequent sloughing. A fracture of the ribs is not uncommon.

**DIAGNOSIS.** With or without fracture there is loss of function of the muscles, so that the patient usually adopts abdominal breathing, and pain is caused by coughing or sudden movement. The injured side is kept as fixed as possible and the lung on the opposite side is given full play by position.

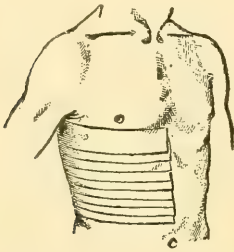


Fig. 536. Strapping of the Thorax.

**TREATMENT.** This consists principally of rest. Straps of adhesive plaster drawn partly around the thorax, or compression by a snugly adjusted bandage, usually give great comfort. Local applications, hot or cold, combined with anodynes, may accompany compression or limitation of motion. Hot, arnicated compresses, one part to eight of water, wrung out as dry as possible and put on with some air-tight material

outside, are often of service. Internally arnica should be given when there is much contusion. Bryonia is often indicated, especially where fracture of rib occurs, with or without displacement. Aconite, gelsemium, and cough remedies may be indicated.

There may be rupture of the vessels of the lung, rupture of the heart or pericardium, or rupture of small blood vessels, which may cause serious hemorrhage, or inflammation. Concussion of the heart may simulate concussion of the brain. Fatal results have been produced even without any lesion of the heart. Blood may be thrown out into the pleura or pericardium, or into lacerated lung substance or the mediastinum, and later cause inflammation. Rupture of the lung may cause emphysema, which may first show itself in the neck or epigastric region. Expectoration of blood or bloody mucus may be present, or hemorrhage from rupture of the lung may be entirely within the pleura. The heart and pericardium may be ruptured without any serious injury to the thoracic wall.

**Wounds.**—Wounds of the chest are non-penetrating or penetrating.

**Non-Penetrating Wounds.**—These vary in extent. In addition to the dangers from hemorrhage, sepsis and ordinary surgical diseases there is especial liability of pleurisy and pneumonia as the immediate sequelæ. Especially is this true of burns involving the chest wall.

**TREATMENT.** Treatment should be that of wounds elsewhere, strict antisepsis should be practiced with removal of all devitalized tissue, drainage, when required, careful suturing, both buried and superficial,



and antiseptic dressings. Homeopathically we have valuable aids in aconite, arnica, bryonia and gelsemium.

**Penetrating Wounds of the Chest.**—These may vary from minute perforations by some pointed instrument or bullet to wounds involving large losses of tissue. They are dangerous, first, because of the liability of hemorrhage which they produce; second, because of the possibility of injury of the viscera; third, from the introduction of some foreign body or septic material, and because they are not amenable to proper cleansing and drainage. The immediate danger of hemorrhage is to be judged of by the condition of the patient and the probable depth and direction of the wound. If the patient expectorates blood the exist-

ence of a wound of the lung may be surmised. If air can be heard entering or escaping from the lung through the wound, or if the blood foams as it escapes from the wound, there is evidently a perforation of the pleura and lung.

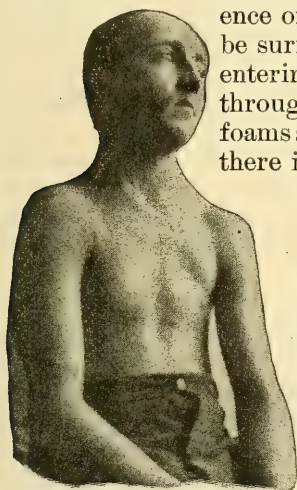


Fig. 537.

**Emphysema—Incipient.**

**EMPHYSEMA.** This is another sign of the perforation of the lung, and may show itself at points distant from the wound. By emphysema is meant the escape of air into the cellular tissue outside of the lung or the intercellular tissue of the lung itself. Of

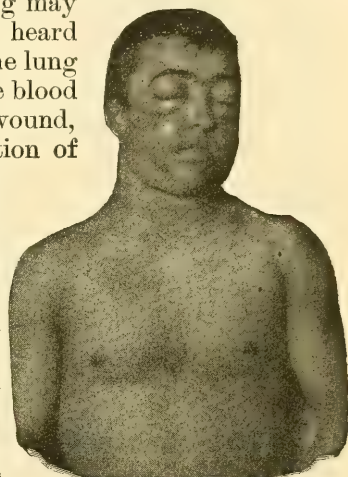


Fig. 538.

**Emphysema—Advanced.**

itself it is not dangerous, but the air may carry with it germs of suppuration or specific disease.

**HERNIA OF THE LUNG.** Pneumocoele, a term implying the protrusion of the lung itself into the wound, is self-explanatory. There is a profound impression on the heart's action. If the collapse is extreme and death rapidly ensues, in all probability the heart or a large vessel has been injured. If the diaphragm is paralyzed there may be injury of the phrenic nerve. If the heart is tumultuous in its action there may have been injury to the pericardium or nerve-supply of the heart. If hemorrhage from the external wound is profuse the probability is that it comes from the intercostal or mammary artery.

**TREATMENT.** The general direction of the wound should be ascertained by the gentle, delicate use of the probe, under the strictest antiseptis. Probing should be done only to determine the general direction of the wound, without attempt to ascertain its depth, the deflection of the instrument or bullet by the ribs or sternum often making a long wound possible without necessary injury of the viscera. Any explorations in small, penetrating wounds to localize the depth of the wound, or to locate or extract the bullet in case of gunshot wound are to be deprecated. Where there are positive signs of alarming internal hemorrhage a bold

operation may be justifiable, as opening the thorax and ligating or resorting to other measures for the arrest of the hemorrhage. Where the wound of the thoracic wall is large, such procedure is advisable. It must be remembered that hemorrhage from the intercostal vessels may be into the pleural cavity and may result fatally. These vessels are usually obscure, and should be sought for wherever the position of the wound implicates them. Injury to the internal mammary vessels may be followed rapidly by all the symptoms indicative of hemorrhage. These vessels lie a short distance from and parallel to the border of the sternum. If emphysema gives rise to any disturbance in itself multiple punctures into the skin may afford relief. Hernia of the lung may require ligation and excision where the portion cannot be reduced, and may necessitate a plastic operation where there has been loss of the bony structure of the chest.

**MEDIASTINAL ABSCESS.** This may be caused by penetrating wounds of the chest, with or without injury of the viscera. It may be the result of severe contusions and fractures of the sternum or dislocation of the ribs and sternum. It may be secondary to abscess of the neck, boring down behind the deep fascia, or to tubercular degeneration in the neck or thorax. It may also be the result of necrosis of the ribs and sternum and may be from the pus in Pott's disease.

*Symptoms.* They are pain, usually referred to this region and aggravated by any sudden movement and efforts at swallowing, oppression of the breath and feeling of weight in the region. There may be more or less edema over the sternum and these symptoms may be accompanied by the constitutional signs of pus formation. These abscesses sometimes attain considerable size and most frequently tend to point just to the left of the sternum. By their juxtaposition to the heart its pulsation may be communicated, which simulates aneurism. Such abscess may also push upward into the neck, or perforate into the pleural sac, or rupture into the lung itself. Pericarditis may occur on account of the proximity to the pericardium.

*Treatment.* As soon as diagnosed the pus should be evacuated. This can be best done by trephining the sternum and exploring with a needle or trochar until the abscess is found, then opening the abscess and draining it. Irrigation should only be resorted to when there is fetor, and should be discontinued as soon as possible. The drainage tubes should be gradually withdrawn and their use discontinued when the discharge is only of such a quantity as would be accounted for by the presence of the tubes.

**Syphilitic and Tubercular Necroses.**—These sometimes attack the sternum and ribs, most frequently at their juncture with the costal cartilages. Where associated with syphilis or tuberculosis these may penetrate through the entire thickness of the sternum or ribs without ulceration involving the skin.

The symptoms would be localized tenderness, pain, with night aggravations, varying in amount from localized discomfort to pains radiating in every direction, localized edema and redness and absence of the deeper pressure-symptoms, thus differing from mediastinal abscess and the local pointing of empyema.

**TREATMENT.** This consists of free incision as soon as diagnosis is made; removal of diseased bone; drainage where it is a chronic process. Where the destruction of bone is due to syphilis unusual care should be given in carrying out the proper constitutional medication, as the tendency is to further necrosis of these flat bones.



## CHAPTER XI.

# DISEASES AND INJURIES OF THE DIAPHRAGM, HEART AND PERICARDIUM.

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**Congenital Defects of the Diaphragm.**—These may exist with defects of the thorax, as fissures of the chest wall (thoraco-schesis), fissures of the abdominal wall extending into the thorax (thoraco-gastro-schesis), or simple defects of the sternum and other portions of the thorax. Through these openings between the abdomen and thorax there may be protrusion of the abdominal viscera into the thorax, constituting diaphragmatic hernia.

Paralysis of the diaphragm may be present in attacks of pleurisy, different forms of poisoning, diphtheria, diseases of the spinal cord and hysteria. It may be paralyzed on one or both sides, and the paralysis may be complete or incomplete.

**SYMPTOMS.** The symptoms are difficulty in breathing, abdominal contraction occurring during inspiration and extension during expiration. All movements which are ordinarily accompanied by fixation or moving of the diaphragm become difficult or impossible.

**TREATMENT.** In idiopathic cases the treatment must be constitutional, with perhaps the use of electricity. In cases due to injuries of the cord, pressure of tumors and fractures, or dislocations of the spine the treatment would, of course, be surgical interference at the point of pressure.

**Wounds of the Diaphragm.**—These may occur from wounds of the chest or abdomen. The diaphragm is occasionally ruptured by the end of a fractured rib, and its perforation may occur with some perforating wound, especially gunshot wounds, where communication is established between the pleural and abdominal cavities. There may be perforation also as the result of abscesses, cystic degeneration of the abdominal or thoracic viscera and tumors. Rupture of the diaphragm may be the result of contusions of the abdomen and chest. These occur more frequently on the left side. Through these ruptures there may be diaphragmatic herniæ. When the rupture is small a single loop of intestine may pass through, or if larger the stomach or portions of the stomach and bowels.

**DIAGNOSIS.** Diaphragmatic herniæ are extremely difficult to diagnose. Symptoms of frequent strangulation accompanied by oppression of respiration, vomiting and excessive thirst are present. Possibly congenital herniæ of this description must be thought of, as there are cases in which there have been no symptoms of strangulation until the traumatism has forced an unusual amount of tissue through the openings. If these occur after several contusions, and if there be exclusion of other possible injuries, operative interference may be justified.

Rupture of the thoracic duct may occur in connection with contusions and wounds of the thorax.

**Chylothorax.**—As a result of a wound of the thoracic duct chylothorax is more frequent than the collection of chyle in the abdomen. It occasionally ruptures into the mediastinum. The symptoms are obscure until there is sufficient pressure in the pleura or mediastinum, when they are those of hydrothorax or empyema. These symptoms of pressure may be so severe as to require operation. Should the evacuated fluid be chyle the diagnosis would be established. If the pressure symptoms are relieved the patient usually gradually sinks and dies from malnutrition.

**TREATMENT.** Besides the relief of the pressure symptoms by thoracocentesis, or opening of the mediastinum, there is but little that can be done surgically. Treatment by starvation should certainly be tried, with the idea that the denial of food would have a marked influence in lessening the pressure of the chyle on the duct and thus afford more chances for the collapsing and spontaneous healing of the rupture. Intravenous injections of milk have been suggested during this treatment by starvation. Should this rupture occur in connection with penetrating wounds of the chest, and the diagnosis be made from the discharge of chyle from the wound, packing the wound with iodoform gauze may afford sufficient pressure to stop the discharge and thus permit of healing.

**Empyema of the Pericardium.**—Effusion may occur as the result of acute or chronic pericarditis, which may be idiopathic or traumatic in its origin. The symptoms of a large amount of effusion are dyspnea, feeble, rapid, irregular pulse, syncope, oppression in the epigastric region, weakening or loss of voice, difficulty in swallowing and usually dilatation of the veins of the neck. The respiratory movement of the left side is more embarrassed. The area of cardiac dullness is increased, both laterally and from above downward. There is absence of respiratory murmurs and muffling of the heart sounds. The apex impulse is higher and further to the left and in extreme cases cannot be detected.

**EMPYEMA OF THE PERICARDIUM.** Empyema may have the same physical signs, with perhaps the addition of symptoms of pus formation. A positive diagnosis should be attempted by the use of a small, aseptic, hollow needle.

**TREATMENT.** Usually effusions of moderate degree require no operative interference. Where the effusion or pus is of so large amount as to cause decided embarrassment of the circulation the surgeon may be called upon to interfere. If diagnosis is confirmed by a small needle a larger aspirating needle or trochar can be introduced. The skin, instruments and operator must be strictly aseptic.

Where simple paracentesis pericardii is done the fifth left intercostal space, one-half an inch to an inch from the edge of the sternum, should be selected, the needle being pushed in obliquely upward and outward to avoid wounding the heart. In this position it would travel from an inch and three-quarters to two inches before entering the pericardium. The fluid should be slowly withdrawn and the effects on the heart and pulse carefully noted. If pus is found incision and drainage must be resorted to. The incision may be made at this point and the opening into the pericardium enlarged by introducing forceps into the opening made by the

needle and then spreading them widely enough to introduce the drainage tube, one-fourth of an inch in diameter. Resection of the rib at this point may even be necessary.

Trephining the end of the sternum and incision and drainage through this opening had better be done where the possibility of a mediastinal abscess exists. There should be no irrigation unless there is putrefaction. The drainage tubes should only just enter the pericardium and be of soft material so as not to injure the heart in case it should come in contact with the tube. The dressings should, of course, be strictly antiseptic. They are usually best retained by strips of adhesive plaster going nearly around the chest. Air-tight dressings externally lessen the necessity for frequent changing.

**Wounds of the Heart and Pericardium.**—These may occur from injuries of the chest wall, such as contusions, or from fractures of ribs and penetrating wounds. A wound of the pericardium of limited extent resembles, as far as symptoms go, a wound of the heart. A wound of the heart is not necessarily fatal. The symptoms are not characteristic. There is hemorrhage, but to a limited extent. Pain in the region of the heart is present, unless the shock is so great that the patient is insensible to pain, in which case a tendency to syncope and weak and irregular pulse supervenes. As hemorrhage from wounds usually takes place into the pericardium symptoms of fluid in the pericardial sac soon appear, as described. The shock is usually great. From traumatism inflammation of the heart itself, as well as of the pericardium, may occur.

**TREATMENT.** The treatment of wounds of the heart and traumatic pericarditis should include absolute quiet, the head of the patient should be kept low to prevent syncope, the tendency to which is usually marked, artificial warmth applied, and although stimulation would be indicated in the treatment of accompanying shock, care should be exercised to avoid over-stimulation. Ether, ammonia and nitro-glycerine should be used with caution, as violent reaction is liable to occur. Homeopathically several remedies might be indicated, as in the treatment of severe shock from other causes: *Veratrum viride* and *album*, *digitalis*, *camphor*, *arnica* and, later, *aconite*, *gelsemium*, *bryonia*, *arsenicum album*, *cactus* and *spigelia*.

**Distension.**—Over-distension of the heart may occur in acute pulmonary congestions from impeded circulation, from rapidly developing aneurisms or from tumors. The possibility of relief of the distressing symptoms by puncture of the distended heart might be thought of in extreme cases, and after consultation. It should be done with a good-sized aseptic needle, so that a sufficient quantity of blood may be quickly withdrawn. The best position is the third intercostal space at the right edge of the sternum. The needle should be thrust directly backward. It must penetrate the skin at the edge of the right lung and pleural sac, as well as both layers of the pericardium, before it enters the auricle.



## SECTION XX.

# SURGERY OF THE DIGESTIVE SYSTEM.

## CHAPTER I.

### DISEASES AND INJURIES OF THE LIPS.

**Erosions and Fissures.**—Strumous subjects, especially in early life, are frequently afflicted with eczematous erosions in the corners of the mouth, which at times ulcerate and in healing leave permanent and disfiguring scars. These patients are also liable to fissures of the lips. The lower lip in its center is most commonly affected. There is a constant tendency to a recurrence of the affection; the sore will heal, again break open, bleed slightly and be painful and annoying. When the condition produces great inconvenience and is unsightly it may be proper to restore the damaged surface by surgical measures. Cocaine should be injected, the edges of the fissure pared and sutures introduced.

The constitutional dyscrasia causing the trouble and which is usually of a tuberculous or syphilitic nature should be treated. Selections can be made from the following remedies: Aurum, arsenicum, calcarea carbonica, graphites, kali hydriodicum, mercurius biniodide, mezereum, nitric acid and thuja. Locally, the following ointment will yield good results:

R.

Hyd. ox. flav.....gr ij

Ungt. zinci. ox.....3 vj

Ol. amygdalæ dul.....3 ij

M. Sig. Apply locally.

**Wounds of the Lips.**—Injuries of the lips often result from a blow or fall, one or more teeth being driven into or through them, inflicting deep and severe wounds; or the injury may be produced by some sharp implement, as a knife or razor. The writer once saw a child whose mouth had been horribly mutilated by the horn of a cow. It is important that these wounds be treated with the utmost care and nicety, so that disfigurement will not follow. They must first be thoroughly cleansed; then if the structures are badly lacerated the jagged edges should be cut away and the surfaces rendered even and smooth-cut. If there is much hemorrhage from the coronary artery it may either be twisted or tied with fine sheep-gut; the cut surfaces are then brought together with deep silk or silk-worm sutures and, to insure perfect coaptation, an occasional fine stitch may be taken in the skin or mucous membrane. The external wound should then be plentifully dusted with

iodoform. The stitches can be removed on the fourth day, before they begin to cut.

**Tumors of the Lips.**—NEVI. Nevi sometimes occur on the lips; they are of the simple variety and are usually found on the lower lip. They may occur as a superficial discoloration of a purplish or port wine hue, or may consist of an abnormal collection of arterioles that involve the sub-mucous tissue. If the growth is small it may be destroyed with the electro-cautery or by electrolysis. If it is larger, involving the sub-mucous structures, it should be removed entire with the knife. An incision should be carried around the growth, the diseased tissue dissected away and the wound accurately closed. In aggravated cases it might be proper to remove a V-shaped flap as is done for epithelioma.

**CYSTS OF THE LIPS.** The mucous follicles in the lips sometimes become occluded. The accumulated secretions from the glandular structures form hard, translucent tumors, varying in size from that of a pea to an almond. They occur most frequently on the lower lip, are of benign character, contain thick, translucent mucus and often give rise to much inconvenience. The cyst wall should be incised, and the cavity treated by an application of strong nitric acid.

**EXCRESCENCES.** Moles, warts and horny growths are sometimes seen on the lips. They should be removed with the knife and the resulting gap closed with sutures.

**MICROSTOMA AND MACROSTOMA.** These conditions are sometimes met with. The former is a congenital contraction caused by an over-closure of the buccal fissure; the latter is due to non-closure of the buccal fissure. The deformity may be of such an aggravated degree that the mouth actually extends from ear to ear.

**Hypertrophy or Double Lip.**—Hypertrophy occurs in strumous subjects and may involve both lips. The condition may assume the appearance of double lips and may be of such a deforming nature as to demand surgical care for its relief. Horizontal incisions should be made and a V-shaped section removed of sufficient size to overcome the hypertrophy. The cutting should be done near the inside border, in order to cover up the scar as much as possible. The fissure should be accurately closed with fine silk ligatures. Animal ligatures will not answer as they will become loosened.



Fig. 539.

**Epithelioma of the Lip, Beginning in a Fissure.**

**Epithelioma.**—Epithelioma of the lip is not an unusual disease. It occurs most generally between the ages of thirty-five and sixty years, and attacks the male much more frequently than the female. It is fifty times more common on the lower than the upper lip, and, what is peculiar, it develops more often on the upper lip in women than in men. The disease is often caused by the continuous use of the clay pipe; therefore it is common among the laboring classes. It develops either as a crack or a fissure or a papilloma (Fig. 539), which persistently refuses to heal. Sometimes it commences

as an indolent tubercle, which ulcerates and is covered by a thick crust that is soon reproduced when removed. The ulcer presents an irregular,

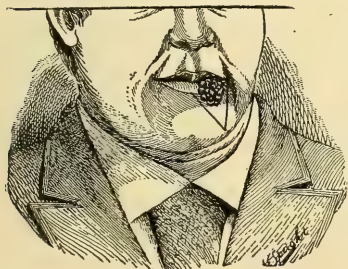
jagged base, with raised or everted edges, and is surrounded by a zone of induration. The ulcerative process, though not very painful, is often attended with a feeling of discomfort. The progress of the disease at first is usually slow, especially in the aged, but in the later stages the advance is more rapid. The lymphatic glands in the sub-maxillary region, when the disease is allowed to run, soon become affected, and in the later stages the glands in the neck become greatly enlarged, finally ulcerate and form deep ulcers, in the bottom of which the pulsation of important arteries can be seen. Death is due to exhaustion, caused by repeated hemorrhages, or to septic infection and its consequences.

**DIAGNOSIS.** A distinction must be made between chancre, lupus and rodent ulcer. In chancre the sore has an indurated base, heals within a few weeks, and the lymphatic glands become involved early; other constitutional manifestations soon appear and the disease is very amenable to treatment.

Lupus occurs chiefly in young adults, and is very chronic in its nature; the ulcer is irregular in its outline and surrounded by a base of semi-translucent tubercles. The surface is covered with a scab and has a tendency to heal with a thin cicatrix that again breaks down.

Rodent ulcer develops in late life and runs a slow course. The ulcer is circular, with hard, round, everted margins, and a smooth and glossy surface.

**TREATMENT.** The successful management of epithelioma is purely surgical, as neither local nor constitutional therapeutical treatment has any curative action upon the disease. The operation should be done early, before the sub-maxillary lymphatic glands become involved. The incisions should extend well into the bounds of healthy tissue, as the disease has a tendency to spread laterally under the epithelium. As the results of operations for epithelioma are good every persistent sore that occurs on the lips of persons over forty-five years of age, with suspicious symptoms of malignancy, should be excised.



**Fig. 540.**  
**Warty Epithelioma;**  
**Lines of Incision for Removal.**

**OPERATION.** The affected portion of the lip should be removed by a V-shaped incision (Fig. 540) and the edges of the wound approximated by deep silk-worm sutures, and the skin and mucous membrane carefully coaptated by a few extra fine silk stitches. The wound heals by first intention and the sutures, or some of them, may be removed at the expiration of the fourth day.

When the sub-maxillary or sub-mental lymphatic glands are enlarged they should be dissected out. If these and the underlying structures are extensively involved operative interference will offer but little prospect of relief. When the disease has invaded the lip extensively it may have to be cut entirely away and a new lip formed from adjacent parts. This operation comes under the head of plastic surgery.

The early removal of an epithelioma of the lip is frequently followed by good results. Recurrence, when it does occur, usually takes place along the line of the scar, though it may be in the sub-maxillary lymphatic



phatic glands, or near the angle of the maxilla. In a large percentage of cases the recurrence is delayed for one, two, three or more years, but occasionally the operation is followed by a quick return of the disease, and this in cases where the primary lesion is small. The mortality following operation is nil.

**Chancre of the Lip.**—Chancre of the lip may be contracted innocently, as from a kiss, the use of a pipe, spoon, fork or any other contaminated article that may come in contact with an abraded surface, or it may be acquired by perverted sexualism, as coitus in oris. The ulcer is generally superficial, with the characteristic indurated base, attended with slight pain, slow in healing and soon followed by the usual lymphadenitis and all the general manifestations of syphilis. It must be diagnosed from lupus and epithelioma. The treatment is the same that would be used in chancre of other portions of the body.

**Salivary Fistula.**—Any injury that severs the continuity of Stenson's duct may produce this lesion. It may be caused by a stab-wound, by an abscess of the parotid gland, or it may result from an injury inflicted during a surgical operation. The condition entails much inconvenience and discomfort. During mastication the saliva trickles through the fistulous orifice, sometimes running down over the face of the patient in a tiny stream.

The object of treatment is to re-establish an internal opening and turn the flow of saliva again into the buccal cavity. This is done by passing a seton through into the mouth. An ordinary perineal needle, double-threaded with a heavy silk ligature, is entered at the external fistulous opening, passed forward along the course of Stenson's duct until the anterior border of the masseter muscle is reached; the point of the needle is then directed inward and made to enter the mouth. The thread is caught, drawn forward and the needle removed. Both ends of the thread are now heavily knotted to prevent its accidental removal, cut short and

left in position, serving the purpose of a seton. In six to eight weeks an artificial opening is established in the mouth and the ligature may be removed. The external wound usually heals promptly. If it fails, cocaine may be injected, the cicatricial tissue cut away and the wound closed with sutures.

**Cancrum Oris.**—This is a gangrenous condition of the mouth that develops in ill-nourished or strumous children who live in unsanitary surroundings. It sometimes attacks weakly children convalescing from some of the eruptive diseases, as measles or scarlet fever. It begins as a phlegmon on the cheek or lips, is progressive in its nature and leads to serious sloughing and destruction of tissue.

The cheek may be extensively perforated and the entire side of the mouth opened, exposing the jaw and teeth in a most unsightly manner (Fig. 541). The first external manifestation of the



Fig. 541.  
Cancrum Oris.

disease may be a purplish blush upon the cheek. Upon inspecting the mouth a large slough will be found upon the inside of the cheek; this may extend to the jaw and tongue and even involve the bone, destroying the alveolar processes and allowing the teeth to drop out. The odor from the mouth is horribly offensive, the pulse is weak and rapid and the prostration extreme. Death may occur from exhaustion within a few days.

**TREATMENT.** The internal administration of such remedies as arsenicum 3x, china 1x, mercurius cyanodide 6x, kali muriaticum 3x and lachesis 6x will be found beneficial. Locally the application of mild solutions of chlorate of potassium, permanganate of potassium or carbolic acid may be tried. Dusting the parts with boric acid and iodoform, in equal parts, or sub-nitrate of bismuth three parts and euophen one part may be of service. The child should be kept on nourishing liquid food, as beef juice, eggs and brandy, cream diluted with barley water, chicken broth, beef peptonoids, etc.

If the patient recovers extensive plastic operations will be necessary to correct the unsightly deformity.

**Ulcerative Stomatitis.**—This disease usually occurs in children of delicate constitution after the first dentition, and is generally preceded by gastric derangement. The inflammation begins on the margin of the gums, develops an apthous ulceration, rapidly extends to the lips and tongue, and may involve almost the entire buccal cavity. The ulcers are generally superficial, involving only the mucous structures, and have a grayish-white base and a firmly adherent membrane. The tongue and lips become swollen and painful, the sub-maxillary glands enlarge, the saliva constantly dribbles from the mouth and the breath becomes offensive. The patient is feverish, restless and fretful, and the appetite is greatly impaired. The disease runs a course of from six to ten days, unless of mercurial origin, when the teeth may become loosened and the alveolar processes necrosed.

**TREATMENT.** The remedies par excellence are: mercurius biniodide 3x and sulphuric acid 1x; nux vomica, arsenicum, kali muriaticum and hepar sulphur are often called for. Local washes of chlorate of potash may be used. A valuable antiseptic and soothing application is:

R  
 Acid carbolici.....gr. iv.  
 Sodii bibor.....℥ j.  
 Glycerini.....  
 Aquæ a a.....fl ʒ ss.  
 M. S. Apply every one to three hours with camel's-hair brush.

## CHAPTER II.

# MALFORMATIONS AND DISEASES OF THE TONGUE.

**Tongue-Tie.**—This condition is caused by congenital malformation of the frenum. The deviations vary in character and extent. The attachment may be too broad or it may extend too far forward, causing difficulty in sucking and, later, interfering with articulation. When the condition produces functional disturbance in the tongue the faulty bands should be divided with a pair of blunt-pointed scissors. In performing this operation some care should be used lest one of the ranine arteries, which course along the under surface of the tongue, be injured. The point of the scissors should be directed downward and the cut made in the direction of the floor of the mouth. Sometimes the frenum may be unduly lax, so that the tongue can drop backward until its dorsum rests against the wall of the pharynx and, in rare cases, over the glottis. Cases are recorded where death has been caused by the condition.

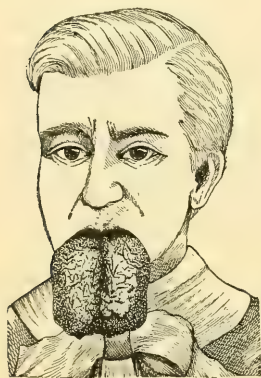


Fig. 542.  
Macroglossia.

**Macroglossia.**—This term is used to designate a congenital enlargement of the tongue. (Fig. 542). The condition is rare and is sometimes associated with hydrocele of the neck. The pathological changes do not involve all the component structures of the organ, and the overgrowth does not involve the muscular substance. There is an increase in the connective tissue, lymph spaces and lymphatics in connection with the lingual membrane. The enlargement is often not noticeable at birth, but the tongue increases disproportionately with the growth of the child, the anterior two-thirds of the organ being mostly involved. Great inconvenience is caused by the disease. The tip of the tongue protrudes from the mouth and in severe cases reaches almost to the sternum.

It interferes with speech and deglutition, everting the lips, enlarging the jaw and forcing the teeth from their perpendicular line. The saliva dribbles from the mouth and the chin becomes the seat of an eczematous eruption. While the shape of the tongue may remain to a certain extent natural the surface is covered with enlarged papillæ, and from exposure becomes dry, cracked and ulcerated. Owing to the constant exposure of the organ it is the recipient of repeated injuries which lead to frequent attacks of inflammation with consequent morbid results.

The treatment is purely surgical, as other measures offer no hope of relief. A V-shaped portion of the tongue should be excised, which is best done with the knife or scissors. The organ is drawn well forward and a vertical wedge-shaped section removed. If the tongue is thick a horizontal section should also be made. The bleeding vessels should be secured and the surfaces brought together with deep silk sutures—sheep-gut



will not answer here as the constant movement of the tongue will invariably cause the knots to untie. The after treatment consists in repeatedly cleansing the mouth with weak antiseptic lotions and the administration at frequent intervals of liquid food. The stitches should be removed on the sixth or seventh day. As a local application nothing will give greater satisfaction than the following; it is soothing, cleansing and mildly antiseptic:

R.

Carbolic acid..... ʒ ss

Tr. calendula off..... f ʒ ijss.

Glycerine..... f ʒ j.

M. S. Add one table-spoonful to water Oj.

Apply locally.

**Acute Glossitis.**—This term is used to designate an infiltration of the parenchyma of the tongue, either partial or complete. The disease may be caused by cold, wounds, mercurial poisoning, the stings of insects, as the wasp or the bee, or it may follow in the course of erysipelas or the eruptive diseases. The most serious cases are those produced by anthrax of the tongue.

Partial glossitis begins as a circumscribed tumor, varying in size from that of a pea to a chestnut. The swelling is painful and sensitive but excites very little if any constitutional disturbance. It may subside by resolution or it may suppurate and discharge.

Diffuse glossitis involves the entire structure of the tongue. The disease develops rapidly and the organ soon acquires enormous proportions, filling the mouth and pressing heavily against the teeth, causing great induration and ulceration. The surface becomes dark and livid, the salivary secretions are greatly augmented, articulation and deglutition become impossible; the sub-maxillary glands enlarge and become sensitive; the breathing becomes labored and suffocating, and the suffering of the patient is extreme. The course of the disease is rapid, terminating in death by asphyxia, in the formation of an abscess or in resolution.

**TREATMENT.** Apis, great burning and stinging pains with blisters on the tongue.

Arsenicum, burning pain, great thirst for small quantities, restlessness, tendency to gangrene.

Mercurius solubilis, tongue thick, broad and flabby, increased salivation, great thirst, ulceration.

The mouth should be frequently washed with a mild carbolic acid or chlorate of potassium solution. If any projection can be felt, indicating the formation of pus, it should be promptly opened. Where the swelling is severe an incision along the dorsum of the tongue on either side of the central line should be made. This will allow the inflammatory effusions to escape. If suffocation seems imminent tracheotomy may be demanded. Both food and water may be given by enemata.

**Chronic Superficial Glossitis.**—(Figs. 543, 544). Superficial inflammation of the tongue is of peculiar importance, owing to its obstinacy and the liability to develop epithelioma. The condition assumes many forms that have been variously designated as leucoma, leucopakia, ichthyosis, psoriasis, tylosis, keratosis, etc. These are all different manifestations of superficial inflammation. The disease is produced by

hot and irritating articles of food, tobacco smoke, spirits and syphilis. Yet there are patients who suffer from the disease who have never been addicted to excesses in smoking or drinking and who have not had syphilis.

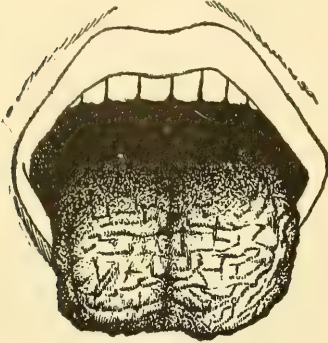


Fig. 543.

Chronic Superficial Glossitis.

Early stage, with slight enlargement.



Fig. 544.

Later stage, with dense coating of epithelium, cracked and fissured.—Moullin.

The trouble is more common in men than women, and rarely occurs under the age of forty years. It is most frequently met with among the laboring classes. The disease arises from some point of irritation, usually where the point of a tooth or the stem of a pipe chafes the organ. The inflammation may remain for a long time confined to a small patch, finally and gradually extending its limits: while in other subjects, who seem to be particularly predisposed to the affection, the whole surface soon becomes involved. The appearance of the tongue varies with the different stages of the disease. In the beginning the inflammation may be confined to one or more spots; the mucous membrane covering the affected surface is hyperemic, reddened and smooth in appearance, and while there is an edematous condition it is not noticeable, unless a large area is involved. As the disease advances the hypertrophy of the epithelial structures increases, the tongue enlarges and fills the mouth, causing indentation of the teeth around its edges. The dense, thickened epithelial covering becomes opaque, bluish-white and presents a sodden look like the epidermis of the hand after it has been poulticed. The flexibility of the organ is lost, its movements are impeded and sometimes it shrinks in size, becoming dense and hard, with fissures running both longitudinally and transversely. In severe cases the inflammation extends to the floor of the mouth, palate and lips. The tongue is usually tender, but the patient suffers little from actual pain. In the later stage there is a loss of taste and a feeling of stiffness and discomfort.

The prognosis as to a permanent cure is unfavorable, as there is a tendency to the development of malignancy.

**TREATMENT.** All sources of irritation should be removed, irregular and jagged teeth extracted and the use of the pipe prohibited. Antiseptic and soothing washes should be used, lotions of carbolic acid, borax and calendula being among the best. When the cause is of a syphilitic nature the daily application of chromic acid, five grains to the ounce of water,



will be found beneficial. Caustics are to be condemned. When the inflammation is circumscribed and the source of irritation can be removed the diseased area should be excised. The internal remedies to be considered are kali hydriodicum, nitric and muriatic acids, mercurius and arsenicum.

**Chancre of the Tongue.**—Primary syphilitic lesions of the tongue are rarely encountered. The infection usually occurs through osculation. The chancre is generally located on the tip of the tongue. Like all syphilitic lesions it is quite free from pain, the induration is well marked and the glandular affection and other secondary manifestations develop in regular order. In healing it leaves a smooth, pale, depressed scar.

Mucous patches of the mouth are of almost universal occurrence in syphilitic patients. They develop about the tonsils, pharynx, tongue and lips. On the tongue they present a variety of forms. On the dorsum they appear as round, or irregular, raised patches covered with a dirty-white, puriform secretion; on the margin where they chafe against the teeth and become irritated they develop into irregularly formed ulcers, under the tongue they may form cauliflower-like projections. Unless ulceration develops mucous patches are painless and subside without leaving a scar. When sufficient irritation exists the area becomes inflamed and ulcerated. The ulcer extends deep into the mucous tissue, has irregular and jagged edges, may become quite sensitive and in healing often leaves an irregular, superficial scar.

**Gummy Lesions of the Tongue.**—These are a late manifestation of a syphilitic disease. They usually develop long after the primary symptoms have subsided, and therefore may be mistaken for epitheliomatous growths. They begin deep in the substance of the tongue, forming at first ill-defined swellings that gradually enlarge, soften in the center, ulcerate and discharge, leaving deep, sloughing cavities with ragged edges and indurated bases. The process of ulceration is slow, the discharge slight, the pain insignificant and the consequent cicatrization disfiguring. In some cases there may be multiple foci of development, the exudations being diffuse; the small tubercles, beginning as white excoriations, run one into the other, producing ulcers of an irregular outline that are obstinate and difficult to heal. In other cases elevated patches form upon the surface of the tongue that are smooth and white in appearance, in which the mucous membrane and sub-mucous tissue become infiltrated and indurated. They gradually break down, forming indolent and irregular ulcers and fissures.

The various forms of syphilitic affections of the tongue rarely occur in regular order. They may develop singly or multiplex or they may run one into the other; again, they may be complicated by other affections and extraneous influences. The inflammation, ulceration, sloughing and cicatrization incident to these various lesions of the tongue may distort, disfigure and greatly change its histological formation.

**DIAGNOSIS.** Epithelioma is the principal disease from which syphilitic lesions must be differentiated. The history of the case and the influence of treatment will greatly aid in forming a correct conclusion. When a doubt exists the microscope should be brought into requisition.

**TREATMENT.** The constitutional treatment is the same as would be used in syphilitic developments in other parts of the body. (See



Syphilis.) Much attention should be given to the local management of the case. Frequent washes of chlorate of potash, one drachm to the pint of water, or borax, two drachms to the pint, may be used. When the ulcers are obstinate chromic acid, five grains to the ounce of water, should be applied with a brush. All sources of irritation must be removed and all habits tending to aggravate the affection interdicted. The diet should be digestible and nourishing.

**Tubercle of the Tongue.**—Tubercular lesions of the tongue usually develop on the tip or dorsum. The disease generally appears as a minute, translucent vesicle of the mucous membrane, gradually extending until it breaks down. Fresh vesicles develop and in this way run one into the other until a deep, jagged, irregular-shaped ulcer is formed with pale and flabby walls and but slightly indurated base. As the ulceration advances it becomes highly sensitive and sometimes acutely painful, so much so that mastication is rendered difficult. The disease may develop primarily or it may be a secondary manifestation of a tubercular condition existing in other organs. The male sex seems to be more frequently affected than the female.

**DIAGNOSIS.** The diagnosis is at times obscure, and the condition has often been mistaken for epithelioma or syphilitic ulceration. The existence of a tubercular history, and the absence of induration about the base and walls of the ulcer, will be distinguishing factors in the first instance, and the presence of other constitutional manifestations will aid in clearing up the mystery in the second.

When the affection is secondary to tubercular disease of the lungs or pharynx the prognosis is very unfavorable; but where it appears as a primary lesion of the tongue it is more amenable to treatment.

**TREATMENT.** Careful attention must be given to the diet; nourishing and digestible food should be administered, and where the stomach will tolerate it without impairment of the digestion cod-liver oil should be prescribed. For internal administration a selection may be made from such remedies as arsenicum, apis, belladonna, calcarea carbonica, calcarea phosphorica, kali hydriodicum, mercurius, nitric acid, petroleum, lachesis, etc. Locally the mouth should be frequently washed with mild antiseptic and astringent lotions. If the pain is severe it may be modified by the frequent application of the following:

R	
Carbolic acid . . . . .	gr. x
Biborate of soda . . . . .	ʒ ij
Glycerine . . . . .	
Water . . . . .	aa fl ʒ j
M. S.	

Apply with brush.

The use of pure campho-phenique will also have a soothing effect. If the pain is too great a two or four per cent. solution of cocaine may be used.

In primary tubercular lesions of the tongue the diseased area may be excised and the wound closed, if possible, with sutures. In such cases healing by first intention may follow and a rapid cure result. Curetting, if thoroughly done, will at times answer the same purpose.

**Nevi.**—When found upon the tongue they are usually situated near the surface. They are slightly elevated, smooth, soft, of a purplish-red color, and disappear upon pressure. In many instances they give but little inconvenience, but they may grow slowly and in time develop into a dangerous, erectile tumor. They are sometimes wounded by striking against a sharp or jagged tooth, or they may be abraded by hard particles of food undergoing mastication. In such instances the hemorrhage may be very severe and frequently recur.

**TREATMENT.** If the growth is small it may be destroyed by the galvano-cautery, but if prominent and of considerable size it should be excised. The operation is best done with the scissors. The incision should be carried entirely around the growth within the bounds of healthy tissue and the diseased structures dissected away. If this method is pursued but little hemorrhage will follow. If any considerable bleeding should develop a sharply curved needle, armed with a strong silk suture, should be passed deep into the tissue and the ligature tightly tied. Sometimes it will be necessary to excise a large portion of the organ; in such cases proper flaps should be formed and the cut surfaces coaptated with silk ligatures.

**Papillomata or Warty Growths on the Tongue.**—These are of rather frequent occurrence; they develop at all ages, are usually small and consist of hypertrophied papillæ. They must be differentiated from epithelioma. In early life it is easy to distinguish them, but after the age of forty years it is more difficult to make a diagnosis. In the warty growth there is an absence of the induration that is so characteristic of epithelioma.

**TREATMENT.** They may be removed by clipping them away with the scissors, and perfectly destroying the base with the galvano-cautery. If there is any induration at the base or the slightest suspicion of malignancy they should be removed by excising a liberal portion of the surrounding healthy tissue with them. To prevent a recurrence such remedies as *calcareæ carbonica*, causticum, nitric acid and *thuja* may be administered.

**Dermoid Cysts.**—These neoplasms are rarely sufficiently developed in the infant to attract attention and are most frequently met with in the young adult. They usually develop in the median line from the hyolingual canal. The walls are composed of fibrous tissue and lined internally with squamous epithelium. The cysts contain epithelial cells, hair, sebum and cholestrine. They usually cause the floor of the mouth to bulge on either side of the frenum and when large produce a prominence under the chin. Sometimes the tumor reaches such dimensions that it projects from the mouth, (Fig. 545). When small, dermoids may be removed from the floor of the mouth, but when they are large, the dissection should be made through the median line, the incision extending from the chin to the body of the hyoid bone. To insure against the possibility of a return of the growth, the cyst wall should be completely and accurately removed.



Fig. 545.  
Large Lingual Dermoid.



**Mucous Cysts.**—Mucous cysts, like those found upon the lips and cheeks, and chronic abscesses also sometimes develop in the tongue.

**Lipomata.**—Fatty tumors may arise between the muscles of the tongue. They protrude from the substance of the organ in a polypoid form. They should be excised by an elliptical incision, and the wound be closed with fine silk sutures.

**Lympho-Sarcomata.**—These growths of the tongue have been reported, but they are of rare occurrence. When encountered the tongue and tumor should be removed together. The disease usually returns quickly and destroys the patient.

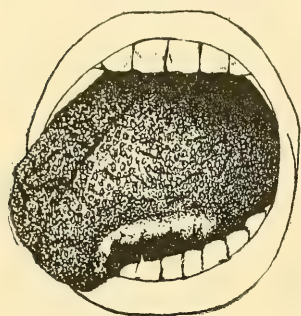


Fig. 546.  
Epithelioma of the Tongue.

**Epithelioma.**—This is the form of cancer that invades the tongue. It usually makes its appearance after the age of forty-five and is more frequently met with in men than in women. Its point of election is the anterior third of the organ, usually on the side or the tip, though it may develop on the dorsum, but always on one side of the median line, (Fig. 546). While this growth of the tongue may arise without any pre-existing cause, it usually starts from some point that is subject to constant irritation. The exciting cause may be the injury inflicted by a jagged tooth, the stem of a pipe; or the application of caustics,

syphilitic lesions, ulcers and scars from any cause may be the seat of the growth. (Sharp-toothed forceps must not be used for the withdrawal of the tongue during the anesthetic state). In about twenty per cent. of the cases it is preceded by leukopakia and ichthyosis. But it does not follow that every ichthyotic patch develops an epithelioma, nor does the disease when it attacks the organ always begin in such spots, though they may be present. It may start as a nodule in the substance of the tongue, or as an induration at the base of a papilloma, ulcer or fissure. Persistent ulcerations or fissures of the tongue in subjects past the middle age of life should always be viewed with suspicion. They should be removed by an incision that includes a liberal amount of healthy tissue. It is bad practice to cauterize these sores; such treatment will not cure them, and it may be the means of exciting malignancy. Whatever the form of the primary lesion, epithelioma soon develops into an irregular, sloughing ulcer, with indurated base and borders. The disease runs a rapid course, terminating life in from six to twenty-four months. The infiltration that supervenes limits the movements of the tongue; the lymphatic glands in the neck are early affected and the disease soon involves the lips, cheek, soft palate, tonsils, and finally the jaw-bone. Pain is a prominent symptom and may be present from the first; in the latter stages it becomes intense, extending over the whole side of the face and shooting upward into the ear. The salivary secretions are increased and constantly flow from the mouth; speech and deglutition become almost impossible and a horrid odor is given off from the foul, sloughing ulcer. Death usually ensues from exhaustion, the result of pain and inability to take food. It may occur from hemorrhage, when the ulceration opens the carotid or lingual artery. Occasionally it is due to asphyxia, which may



be caused by edema of the glottis, or by pressure upon the trachea by the enlarged glands. In a few instances death results from septic pneumonia, superinduced by inhaling the fetid discharges from the mouth.

**DIAGNOSIS.** Diagnosis in the earlier stages of cancer is quite difficult; the disease must be differentiated from syphilitic lesions, and simple and tubercular ulcerations. The history of the case and the manner of invasion will greatly aid in distinguishing epithelioma from syphilitic ulceration. In primary manifestations of syphilis the induration precedes the sore, while in epithelioma it comes after. It is much more extensive and keeps pace with the rapid advance of the disease. The glandular involvement is also more extensive in the case of an epithelioma and there is an absence of the integumentary eruption so universal in syphilis. In tertiary syphilis the tongue lesions are usually multiple, while with epithelioma they are single. If a doubt exists an examination of a portion of the morbid growth with the microscope will clear up the diagnosis.

In simple ulcer there is an absence of induration and lymphatic complication, and upon inspection of the mouth there will usually be found a source of irritation to account for the abrasion. It may be caused by the stem of a pipe, a jagged tooth or a chronic superficial glossitis.

In tubercular ulcer there is usually a history of tuberculosis. The induration is less than that associated with epithelioma, and the glandular invasion is not so marked. An examination with the microscope, if of tubercular character, will reveal the tubercular bacilli.

In the later stages of epithelioma where the disease has made serious advances the symptoms and conditions are so well marked and so distinctive that a mistake in diagnosis is hardly possible.

**PROGNOSIS.** If not recognized early, and promptly treated by radical surgical measures, the growth runs to a fatal termination in from six to twenty-four months. When the operation is done early before systemic infection has taken place and is thorough in its execution the prospects of complete recovery are more favorable; at least life is prolonged and the suffering is at times greatly abridged.

**TREATMENT.** The rational management of a case of epithelioma of the tongue resolves itself into purely surgical measures. Any other form of treatment is not only unavailing, but actually injurious. Early removal offers the only hope of a cure and insures the greatest immunity from suffering. Where the disease is localized or limited to a small area on the anterior portion of the tongue a partial excision of the organ will answer; the operation is free from complications and devoid of risk. However, in almost every instance complete removal is to be preferred, as by this procedure the chances of recurrence are minimized. It has been observed that where half of the tongue has been excised the after trouble is even greater than when the entire organ has been sacrificed. There are more inconveniences, ptyalism and after-pain. As time passes the remaining half, through cicatricial contraction, is drawn toward the opposite side and becomes a distorted and useless mass.

Where the growth is so small that an extensive mutilation of the tongue is not deemed necessary the diseased portion can be excised by a V-shaped incision and the cut surfaces coapted with sutures; this is especially advisable when the involvement is on or near the tip. If the

shape and position of the wound are such that suturing cannot be accurately done the wound may be left open to fill in by granulation. The bleeding may be controlled by sponge pressure.

When the disease has largely invaded the organ or has involved the mouth so that it becomes necessary to make wide dissection in its removal the operation then becomes one of very serious import.

One of the chief obstacles encountered is hemorrhage. This comes principally from the lingual arteries; while these vessels are not large and the amount of blood that they discharge is not great the inaccessible locality in which the manipulations are being conducted makes it difficult to operate with even slight bleeding. In cases where the disease is extensive, and it becomes necessary to remove the tongue far back, a preliminary ligation of the lingual arteries through incisions in the neck will prevent the hemorrhage and thereby simplify and expedite the operative procedure.

When preliminary ligaturing of the lingual artery is not deemed necessary the bleeding may be largely controlled by placing the fingers of one hand beneath the lower jaw, just in front of the hyoid bone, and firmly pressing the floor of the mouth upward; this puts the lingual arteries upon a stretch and controls the bleeding. It also brings the cut surfaces of the tongue well into view. Heath, of London, has accomplished the same end by hooking the finger around the base of the tongue in the pharynx and drawing the bleeding stump forward. It is a feasible plan to draw the tongue well forward, cut boldly through the tissue with the scissors and seize the lingual arteries with catch-forceps as they are divided.

It is an important point in operating to prevent the blood from passing down into the trachea and thereby causing suffocation, or by being drawn into the lungs during respiration, as it may at a later date cause septic pneumonia. This can usually be prevented by elevating the shoulders and inclining the head forward and to one side, or if the operation is to be very extensive a preliminary laryngotomy should be performed.

The mortality after excision of the tongue is not great considering the locality and the severity of the operation. It is about ten per cent. and depends upon the care with which the after-treatment is conducted rather than upon the method of operating. The causes of death are hemorrhage, septic pneumonia, pyemia, septicemia and exhaustion.

While recurrence after excision of the tongue for epithelioma is the rule there are many favorable factors to be considered that recommend its performance. When the operation is done in the early stages of the disease some cases will make a permanent recovery, while in others less favorable the recurrence may be delayed for months or even years. Again, the secondary development takes place in the cervical lymphatic glands and the stump remains free from disease, thereby lessening the pain and suffering. In cases where the disease is advanced to that extent that removal is impracticable the pain and ptialism may be greatly alleviated by a resection of the lingual nerve, or a ligaturing of the lingual or facial arteries; however, when the end approaches the regular administration of morphia offers the only hope of relief from the excessive pain, and to attempt to withhold it is cruelty. The local application of cocaine may afford some alleviation from suffering, but its effect is so transient

and its action in some subjects so depressing that as a palliative it is not reliable.

It is important that as perfect a condition of cleanliness as possible should be observed. The fetor must be controlled by the frequent application of mild antiseptic washes of carbolic acid, permanganate of potash or Condy's fluid. One of the most cleansing, pleasant and soothing is the following antiseptic solution:

R	Sodii bibor.....	3 ij
	Acidi Salicyl.....	3 jss
	Glycerini.....	f 3 j
	Aq. Gault.....	f 3 xv
	M. sig: Apply as wash.	

Hemorrhage, when it occurs, should be checked by pressure or with styptics.

The feeding of the patient after mastication becomes impossible must receive careful attention. As long as the patient is able to swallow, bland and nourishing liquid food should be administered in ample quantities at stated periods. Where the pain becomes so intense when anything touches the tongue that deglutition is impossible, or when the larynx has lost its protection, the food should be given through a funnel or a soft rubber tube. When this process is no longer feasible nutrient enemata may be used.

**Complete Removal of the Tongue.**—Pimperlle, who died in 1658, was the first surgeon who successfully excised the tongue, and Guthrie, in 1756, was the first English surgeon to excise an epithelioma of the tongue. Various methods of operating have been devised, all of which have received special endorsement at the hands of different surgeons. Individual training and personal experience have much to do with the choice. In adopting a method it should always be one that can be carried out to the end with cutting instruments, the knife or scissors, as a clean-cut wound is to be commended. The use of the ecraseur and the galvanocautery cannot be too harshly condemned. The ecraseur leaves a ragged and contused wound, which in a few days presents a sloughing and suppurating surface, while the galvanic wire adds to this a great tendency to secondary hemorrhage when the eschar is cast off.

Before operating careful attention must be given to the mouth in order to render it as aseptic as possible. Mild washes of carbolic acid (two per cent.), peroxide of hydrogen or Condy's fluid should be used several times daily, and all particles of decaying material removed from about the teeth. The face should be shaven, also cleansed with a carbolic (three per cent.) or a bichloride (1 to 2-000) wash.

The instruments necessary are scalpels, curved, blunt-pointed scissors, tenacula, retractors, artery forceps, thumb forceps, needles, needle-holders, ligatures (silk and sheep-gut), Hays' saw, bone forceps, bone drill, aneurismal needle, gag and tracheotomy tube.

Of the many methods devised for the removal of the tongue it is necessary to describe only the following: Whitehead's—excision after ligaturing the linguals—and Kocher's.

**WHITEHEAD'S OPERATION.** Chloroform should be administered, the patient be brought to the right side of the table and the head placed in such a position as will direct the current of blood away from the larynx.



A gag is introduced and the jaws well separated. A ligature is then passed through the tongue near its tip, on which traction is made by an assistant. With the scissors the tongue is separated from the floor of the mouth and the anterior pillars of the fauces, in the meantime drawing the organ well forward. Then by successive snips the muscles that form the base are cut across on a plane with the inferior border of the lower jaw and as far back as can be done with safety to the epiglottis. When the arteries come into view or are cut they are grasped with the catch-forceps and twisted or tied. If any difficulty is experienced in securing them the assistant should be directed to place his fingers beneath the jaw on either side of the larynx and lift the floor of the mouth upward and forward; this controls the hemorrhage and brings the severed arteries into view. After the tongue has been removed the floor of the mouth is washed with a mild antiseptic solution and well dried; no further dressing is necessary.

Preliminary laryngotomy, which adds but slight additional risk, may be deemed necessary when the disease is extensive and much hemorrhage is to be anticipated. The fauces can be plugged so that no blood can possibly flow into the larynx. This procedure renders the administration of the anesthetic easy and the dissections can be proceeded with deliberately. The canula may be removed when the patient has rallied from the anesthetic. Infiltrated glands should be removed by careful dissections through a separate incision.

The after-treatment consists in frequently cleansing the mouth, every one or two hours, with a mild carbolio acid solution, (one per cent.), or the alkaline antiseptic solution (Condy's, e. g.), and instructing the patient to lie in such a manner as to conduct the saliva and discharges from the mouth. Feeding is a most important factor in the after-treatment. Nutrient enemata must be given during the first twenty-four or forty-eight hours and then bland liquids should be administered through the mouth with a feeder. If the patient is unable to swallow, a tube should be used. After every feeding the mouth must be well washed. Since the usual cause of death is septic pneumonia the constant washing of the mouth to control sepsis, though annoying, is a necessity. The patient may be allowed to sit up on the fourth or fifth day.

**INTERNAL TREATMENT.** The principal remedies after the operation to be given internally are arsenicum, aconite, arnica, hypericum, ledum, rhus, ruta and staphisagria.

**EXCISION AFTER LIGATURING THE LINGUAL ARTERIES**—This method was introduced by Meroult in 1833 and revived in late years by Billroth. It is considered by many as the best method of removing the tongue. Where this preliminary ligaturing of the lingual arteries is performed the operation can be conducted in the most deliberate way, without annoyance from hemorrhage.

The lingual artery arises from the external carotid, opposite the great cornu of the hyoid bone, and passes for some distance along its upper border. To secure it the head of the patient is thrown back and turned to the opposite side. A curved incision is made, and, beginning a little below and to one side of the symphysis menti, is carried down to the greater cornu of the hyoid bone, thence outward to the edge of the sterno-cleido mastoid (Fig. 547). The skin, superficial fascia and platysma are divided, care being taken not to injure the fascial vein which

lies toward the posterior angle of the wound. If seen it is pushed to one side. The apex of the submaxillary gland comes into view and fills the upper portion of the incision (Fig. 548). The gland is drawn upward with a tenaculum and a triangle exposed, formed by the two bellies of the digastric muscle and hypoglossal nerve. The floor of this triangle is formed by the hyoglossus muscle. The fat and loose cellular tissue which fill the space are removed. The fibres of the hyoglossus are divided and the lingual artery with its veins is exposed, lying parallel to the hyoid bone. The artery is ligatured and the wound closed by two or three silk sutures. It is not best to close the wound perfectly, as there may be considerable oozing that should be allowed free escape. The artery on the other side is then secured in the same way. If the sub-maxillary

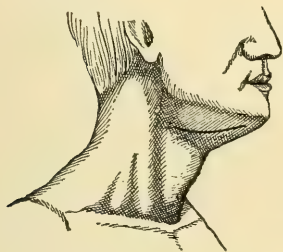


Fig. 547.  
Ligation of Lingual Artery.  
Line of Incision.—Green.

glands are enlarged they should be removed when ligaturing the arteries. After the arteries have been tied the tongue is removed in the same manner as in the Whitehead operation.

**KOCHER'S OPERATION.** This method was described by Kocher in 1880 and is by far the best devised for the removal of the tongue by a sub-maxillary incision. It is to be commended especially where the sub-lingual and sub-maxillary glands are involved.

Before beginning the operation the mouth and nasal passages should be well cleansed with an alkaline and antiseptic wash, a preliminary tracheotomy performed and the pharynx plugged with a clean sponge.

An incision is begun just below the bottom of the ear and extended downward along the anterior border of the sterno-mastoid muscle to its middle; it is then carried forward to the hyoid bone, thence along the anterior border of the digastric to the symphysis. The flap, including the skin, platysma and fascia, is turned upward and the facial vessels and the lingual artery are ligatured. Beginning from behind, the sub-maxillary fossa is cleared of the cellular tissue, lymphatic glands and also the sub-maxillary and sub-lingual glands, if diseased. The mylo-hyoid muscle having been cut and the mucous membrane divided close to the jaw, the tongue is drawn out through the opening, slit through the median line, and the diseased half removed with the scissors. If the whole tongue needs to be removed, which is always best, the opposite lingual artery must be first tied, but through a separate incision. The wound is only partially closed with sutures. It is plugged with carbolized or sterilized gauze and left to fill in by granulation. Every precaution must be observed to insure perfect drainage. The tracheotomy tube is left in position until the wound is found to be in a healthy granulating condition. The dressings are changed twice daily and the wound kept scrupulously clean with mild carbolic acid and calendula or alkaline anti-

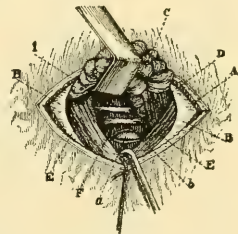


Fig. 548.  
Ligature Right Lingual  
Artery.

A. Platysma. B. Cervical Fascia. C. Submaxillary Gland. D. Mylo-hyoid. E. Digastric. F. Hyoglossus. a. Lingual Artery. b. Ranine Vein. 1. Hypoglossal Nerve.—(Treves.)



septic washes. The ingress of septic matter into the lungs should be prevented, therefore, so long as the tube is left in position, the wound within the mouth pharynx being kept packed with aseptic gauze. The patient should be instructed to avoid allowing any of the discharges from the mouth to pass into the trachea or esophagus.

The mortality after the operation is quite small, considering the fact that it is so formidable. In general it is about ten per cent. but varies with different operators. The usual causes of death are septic pneumonia, pyemia, cellulitis, erysipelas and exhaustion.

In inoperable cases of carcinoma of the tongue that are attended with great pain and salivation, and severe neuralgia of the tongue resection of the lingual nerve may give prompt and sometimes permanent relief. After anesthetizing the patient the tongue is forced toward the opposite side; by thus making the lingual nerve tense it can be felt in the floor of the mouth beneath the mucous membrane. It is cut down upon, lifted up by a hook and excised with the scissors. Removing a section of the nerve is better than stretching, as it gives more permanent relief.

**Wounds of the Tongue.**—These may result from many causes. The organ may be severed by being bitten through, or variously lacerated by the teeth either in falling or by a blow upon the chin. It may also be injured by a gunshot wound, by a thrust with a stick, or a pipe-stem or some other foreign body may be driven into it. Usually these injuries are not serious and require but little if any attention; but there are instances where they are severe and require prompt and intelligent medical skill in their management. Cases are on record where the hemorrhage has been so severe that death followed from exhaustion; in other cases children have died from asphyxia, the blood running into the larynx. Should the hemorrhage be slight it may be controlled by pressure or by the application of ice, but in serious cases it may become necessary to suture the wound. In these cases the patient should be anesthetized, the tongue drawn well out, the bleeding vessels exposed and secured, the wound carefully coapted with silk sutures, which should be securely tied, as the constant movements of the tongue are liable to untie the knots. Sheep-gut sutures should never be applied about the tongue or mouth; they will certainly become loosened. The use of the actual cautery to stop the bleeding is harsh and unnecessary treatment. In stubborn cases, where the hemorrhage is persistent and unmanageable, before the patient is allowed to perish from the bleeding the lingual arteries should be tied. Sometimes foreign bodies enter the tongue and remain imbedded in its structures; they should be removed and the bleeding controlled.

The after-treatment of wounds and injuries of the tongue is the same as after operations on this organ.



### CHAPTER III.

## DISEASES OF THE FLOOR OF THE MOUTH AND SALIVARY GLANDS.

**Ranulæ.**—This is the name applied to cysts that form in the floor of the mouth. The tumor is due to the dilatation of one of the mucous glands that lie on either side of the frenum linguæ, known as the glands of Blandin and Nuhn. Sometimes the swelling arises from an obstruction of the ducts of the sub-maxillary or sub-lingual glands; in such cases the cyst containing the elements of the salivary products. There is now a tendency by some writers to limit the application of the term to those cysts alone. The involvement of the parotid (Wharton's duct) is very rare, but the lesion has been actually demonstrated.

Ranulæ grow to the size of a pigeon's egg. They bulge upward into the mouth, are thin-walled and of a bluish, purplish color. They contain a fluid that resembles the white of an egg, which is rich in mucin and sometimes is stained with cholestrine. The swelling is not usually attended with pain but it produces more or less discomfort. The disease must be differentiated from dermoid cysts, which sometimes develop in the same region.

**TREATMENT.** The treatment of ranulæ, ordinarily, is not very satisfactory. A portion of the cyst wall should be excised and the cavity wiped

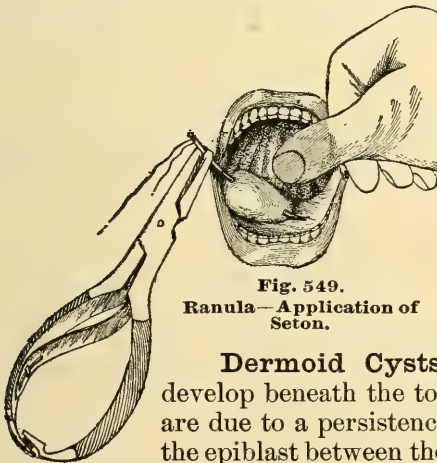


Fig. 549.  
Ranula—Application of  
Seton.

out with an irritating substance, as nitrate of silver, iodine or carbolic acid, and packed with gauze, which will cause granulations. A seton may be introduced (Fig. 549), or a V-shaped flap may be made and stitched to the floor of the mouth. In obstinate cases the cyst wall should be dissected out entire. This is rather a tedious operation, but the wound heals rapidly and the results are more satisfactory.

**Dermoid Cysts.**—These are congenital cysts that develop beneath the tongue in the floor of the mouth. They are due to a persistence of fetal structures, an involution of the epiblast between the genio-hyo-glossi muscles, or between the genio-hyo-glossus and the mylo-hyoid. These tumors develop slowly and are smooth, round and painless. They contain a substance composed of epithelium, cholestrine, fatty matter and sometimes hairs. The cyst walls, usually tough, may be thin and friable. The tumors do not possess the characteristic semi-translucent and fluctuating qualities of ranulæ, but are dense and doughy. They sometimes attain the size of an orange.

**TREATMENT.** The treatment is by excision, either through the mouth or externally in the sub-maxillary space. The latter method is preferable. A vertical incision is made in the median line between the muscles, below the chin, and when the sac is reached it is drawn out and freed from its attachments with the knife or scissors. If the cyst is small it may be removed through the mouth.

**Epithelioma.**—This is the form of malignant disease that develops in the floor of the mouth. It is caused by some persistent irritation, as that of an ill-fitting plate. It must be diagnosed from simple ulceration. It should be removed by a liberal incision, extending well within the bounds of healthy tissue.

**Acute Inflammation of the Salivary Glands.**—The parotid and sub-maxillary glands are liable to attacks of acute inflammation. The parotid is most frequently affected. It may occur in connection with mumps or may arise from other causes. It develops in some cases of typhoid fever, is often met with in pyemia, and is a frequent attendant of diphtheria, syphilis and tuberculosis; in the latter disorder suppuration is common. In mumps the glands rapidly become swollen, hot and tender and are the seat of frequent, sharp, shooting pains. The opposite glands soon become affected, as does, in some instances, the sub-maxillary. At times the latter is the only gland that is involved. Suppuration seldom follows in mumps, but in inflammation of the glands from other causes it is not unusual. When the pus begins to form the gland rapidly enlarges, the adjacent cellular tissue becomes infiltrated, and the neck and face are greatly swollen. The patient is feverish and at times becomes delirious. The pain is of a severe aching nature and is frequently attended with sharp, shooting paroxysms that run up into the ear. The pus, if not evacuated, may burrow beneath the fascia, passing upward along the course of the nerves to the base of the brain, or work its way into the ear and discharge through the external auditory canal; or it may extend downward beneath the deep fascia.

When the sub-maxillary glands become acutely inflamed the symptoms are also well marked, the space beneath the jaws becoming infiltrated, swollen, indurated, purplish and tender. The sub-lingual is seldom affected, but when it is much the same train of symptoms is present. The locality of the swelling will indicate the gland involved.

**TREATMENT.** Belladonna: Bright red swelling, throbbing pain, restlessness, high fever with the characteristic train of symptoms. Mercurius: Slight redness, pain in glands, increased flow of saliva, tongue broad, thick and covered with whitish coat, slight fever. Rhus tox. Dark red swelling, especially on left side, slight fever, restlessness. When suppuration threatens, arsenicum, hepar sulphur or silicia and mercurius iodatus may be indicated. When the pain and tenderness become severe soothing applications should be used. Carbolyzed gauze moistened in hot extract of witch hazel, dry flannels heated, or a hot water bag may be applied. When suppuration has positively declared itself the pus should be evacuated. If doubt exists as to the presence of purulent matter an exploration should be made in the most likely spot with a hypodermic syringe; a large needle should be selected for the purpose. If the pus is present and deep-seated an incision from half to three-quarters of an inch long should be made with a scalpel down to the fascia, then a director

should be pushed down into the swelling until the cavity is reached. A pair of dressing forceps with the blades closed should be passed along the director and the passage dilated sufficiently to give free exit to the pus. The cavity should be washed with a mild carbolic acid solution.

**Salivary Calculi.**—Calculi sometimes form in the ducts of the salivary glands; they are composed of the phosphates and carbonates of lime, with magnesia and a portion of animal matter. They occur most frequently in the ducts of the sub-maxillary glands. They are usually small, the size of a pea, and give rise to but slight symptoms unless their presence blocks the passage. When they do the gland enlarges, becomes distended and sensitive, sometimes resulting in extensive sub-maxillary infiltration. The stone may be detected by palpation with the finger or by an exploration of the duct with a probe.

**TREATMENT.** The calculus should be released by a free incision through the mucous membrane and removed without crushing. When it is broken the extraction of the fragments becomes sometimes quite difficult.



## CHAPTER IV.

### DISEASES OF THE JAW.

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**Referenda.**—Congenital and acquired deformities of the jaw come under the head of plastic surgery.

**Difficult Dentition.**—While teething is a physiological process and ordinarily should not be attended with pathological disorders it is, nevertheless, a fact that this function, like all others connected with the human organism, may be perverted and serious results follow. Normal dentition depends upon an harmonious relation between the process of development of the teeth and the absorption of the overlying structures. When from any cause this accordance is disturbed an irritation follows. The normally insensitive gum-tissue becomes hyperemic, tumid and tender and the pressure upon the nerve and vascular supply of the pulp of the advancing tooth causes severe and aching pain. This peripheral irritation is reflected to the brain through the anterior and the naso-palatine nerves and their ganglionic connection with the fifth, at times producing profound impressions upon the general system. Therefore dentition may be classed as a prominent etiological factor in the diseases of infants, causing or aggravating such disorders as cerebral hyperemia, sleeplessness, convulsions, paralysis, gastric and intestinal disturbances and other serious lesions.

When dentition produces or complicates the diseases of children a marked degree of nervous excitement exists. The child becomes fretful and sleepless; it rolls its head, clutches at its mouth with its hands and throws itself violently backward and forward, as if in great pain. The salivary secretions are usually aggravated and, at times, the mouth becomes hot and dry and great thirst exists. In some cases there is extreme nervous depression, a steady loss of vital power, and a pronounced state of inanition supervenes. In other cases high fever, vomiting, diarrhea, convulsions, stupor and death make up the picture. Between these extremes there is every grade of symptoms, from a mild functional disorder to the gravest pathological lesions.

Upon inspection the gums appear livid and swollen from congestion, and are highly sensitive to pressure. Sometimes the swelling assumes a tumor-like prominence that is filled with dark, bloody fluid; at other times ulceration will form over the presenting tooth. In some cases a train of morbid symptoms exists where no local manifestations are present, the seat of irritation being located wholly in the pulp of the tooth.

The rational method of dealing with the condition is by free incision. A division of the dense fibrous tissue overlying the offending tooth removes the pressure, relieves the capillary turgescence, allows the accumulated serum to escape and gives almost instantaneous relief. As the primary object of lancing is to remove tension it follows that the cuts should extend through the gum to the presenting surface of the incoming tooth, and be

made with special reference to its form. (Fig. 550). The incisors and cuspids need only a division of the gum parallel with its cutting edge. The molars require a crucial incision. When the point of an incisor tooth protrudes through the mucous membrane the tension is relieved, but not so with the cuspids and molars. These have cone-shaped crowns; therefore, even after the eruption of the points, the pressure is still kept up by reason of the enclosing ring of gum. This requires to be completely severed, both laterally and antero-posteriorly; if the cuts heal before the tooth has fully come through the gum or the symptoms have subsided the operation should be repeated. If much bleeding follows the application of finely-powdered alum will promptly control it.

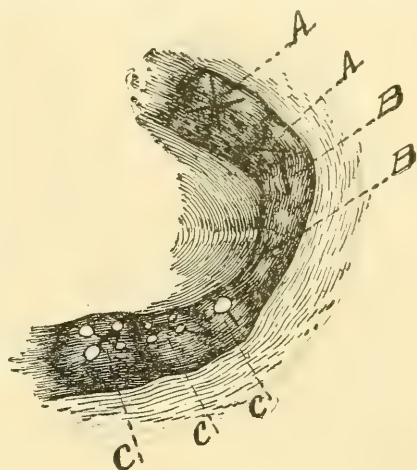


Fig. 550.  
Incisions in Lancing Gums.—Green, Molars, AA, Cuspids and Incisions before Eruption, BB, Molars and Cuspids after Partial Eruption, CCC. (American System of Dentistry).

**MEDICAL TREATMENT.** The peculiar constitutional dyscrasia causing the trouble should be overcome by careful attention to hygienic and dietetic treatment. The child should be regularly bathed and gently but briskly rubbed in order to keep up a healthy circulation; when thin and emaciated it should be bathed daily or rubbed with oil. When the weather is pleasant it should, if not too ill, be kept in the open air. The diet must be nourishing and easily digested; equal parts of cream and barley-water, with the requisite amount of sugar added, make a most useful and agreeable article of food. Nothing will take the place of mother's milk. If it has failed and the child is delicate a wet-nurse should be secured if possible. Such constitutional remedies as calcarea carbonica, calcarea phosphorica, kali phosphoricum, silicia and sulphur should be constantly given. To relieve the urgent symptoms selections should be made from the following remedies:

**Arsenicum.** Child is weak and prostrated; restless, tossing from side to side; great thirst for small quantities of water; diarrhea; water is vomited soon after it is taken.

**Belladonna.** When the infant is tremulous and restless; awakens with a start; face flushed and hot; pupils dilated; convulsions.

**Borax.** Child starts and jumps at the least noise; cries and clutches at objects as if afraid of falling; cannot bear a downward motion; aphthæ in mouth.

**Calcarea carbonica.** Large head with open fontanelles; head sweats during sleep; child peevish and fretful; abdomen distended; stools chalky, thin and watery.

**Chamomilla.** Irritable and sensitive; very cross, wants to be carried; green or yellowish, offensive stools.

**Cicuta.** Child constantly grinds its teeth; half sleeps, with tossing; convulsions.

**Cuprum.** Great uneasiness and tossing; convulsions beginning with cramps in the extremities; green, painful stools.

**Hyoseyamus.** Convulsions beginning with twitching of facial muscles; muttering and picking at bed-clothes.

**Kreosotum.** Very painful dentition, gums dark; offensive diarrhea.

**Veratrum album.** Great prostration, cold perspiration, weak pulse, nausea, vomiting and watery diarrhea.

**Alveolar Abscess.**—Alveolar abscess develops in the apical space and is the result of apical peri-cementitis. The pus forming here is inclosed in bony walls. The pressure induced by its accumulation produces a rapid absorption of the surrounding structures, the fluid burrowing in the direction of the least resistance. During its retention in the bony casement in the apical space the patient suffers from severe pain of a throbbing nature which is sometimes attended with rigors and more or less fever. The gum over the affected root becomes congested, swollen and of a purplish color. As the process of destruction goes on the pus finds an exit through the alveolar walls, usually on the buccal or outer side of the dental arch. The soft structures being less resistant than the osseous the agony of pain is now much modified, though not entirely relieved. An inspection of the gum will show a sensitive, fluctuating tumor over the affected tooth. The side of the face now begins to swell, and rapidly becomes edematous and distorted. As a rule the peri-dental membrane is not destroyed. Its fibres are swollen and elongated, pus occupying the space between them. This swollen tissue (sometimes termed a pus-sack) forms the mass so often seen attached to the root of an extracted tooth. When the peri-dental membrane is destroyed and the end of the root denuded the condition is more serious, and unless the offending tooth is removed it is liable to terminate in a chronic abscess. An alveolar abscess should never be allowed to open spontaneously. As soon as its presence is made known on the side of the gum it should be promptly evacuated by a free incision. The pus, if allowed to remain may burrow under the periosteum of the alveola, separating it from the bone over a considerable space and producing more or less necrosis. Under no circumstances should the abscess be allowed to open on the face, as a fistula or an unsightly scar will surely result.

**DENTAL TREATMENT.** If the case is seen in the early stage, before the pus has broken through the bony structures, it should be referred to a dentist, with the hope of opening up the pulp chamber in order to allow the pus to escape through the tooth. If the tumor has formed a narrow bistoury should be entered in the gum, passed downward along the side of the tooth until the pus cavity is reached and a free incision made. The proper constitutional remedies should then be prescribed and the patient sent to a competent dentist for local treatment.

**MEDICAL TREATMENT.** If the physician sees the patient early, during the acute inflammatory stage, the process of suppuration may be prevented by the administration of the indicated remedy.

**Aconite.** Tooth highly sensitive, with fever, skin hot and dry, patient restless and anxious, much nervousness.

**Belladonna.** Fever, face flushed, throbbing in the affected jaw with tearing pains in the tooth and face, dryness of the mouth with thirst, patient nervous and starts in sleep.



**Dulcamara.** Inflammation brought on from taking cold in damp weather.

**Mercurius.** Tearing pains in the tooth and jaw, excited by cold and worse at night, clammy perspiration and increased saliva, teeth feel sore and too long.

Local application of dry heat to the jaw will greatly aid in relieving the pain and at times will hasten the decline of the inflammatory symptoms. If the tooth is decayed the application of a pledget of cotton saturated with belladonna 1x, or equal parts of pure carbolic acid and iodine tincture, will be beneficial. Sometimes painting the gums with campho-phenique will also relieve.

**Necrosis of the Jaw.**—Necrosis more frequently attacks the lower than the upper jaw. This is largely owing to the different sources of their blood supply. The lower jaw receives its vascular supply from the internal maxillary artery, a branch of the external carotid. The inferior dental artery enters the posterior dental foramen through which it passes, accompanied by the inferior dental nerve, into the inferior dental canal, traversing which it terminates at the anterior or mental foramen in two divisions known as the incisor and mental branches. The inosculation with the opposite vessel being slight, any obstruction to this circulation greatly impairs the nutrition of the bone. The upper jaw receives both blood and nerve supplies from different directions, therefore if the circulation is obstructed from one source it is compensated for by increased flow from another. Necrosis of the jaw may result from many causes, among the most prominent being injuries, eruptive fevers, scurvy, syphilis, periostitis, peri-cement-titis, mercurialization and the action of phosphorus. The condition is usually preceded by a periostitis and most frequently affects the outer part of the bone. It is always preceded by severe pains which are deep-seated and accompanied by inflamed and swollen gums. The teeth become loosened and the burrowing pus causes absorption of the bony tissue, opening up sinuses or points of exit in various directions. Septic symptoms appear and the general health becomes impaired. The necrosis may be limited to the bone covered by the diseased periosteum, or it may extend deeper, involving the alveolar borders and, in the upper jaw, the palate bones. A central sequestrum is met with in the lower jaw but not in the upper. Necrosis limited in extent and confined to the hard palate is suggestive of syphilis. The disease often extends from the jaw to adjacent bones and may involve structures that produce fatal results. Repair after necrosis is more perfect in the lower jaw than in the upper. The palate bones when destroyed are never reproduced, therefore perforations in these bones require plastic operations for their closure. Some of the worst cases of necrosis of the jaw are caused by mercurialization. This drug seems to have a special affinity for this region and at times produces most devastating effects.

**TREATMENT.** When the pus is forming free incisions made into the affected tissue to relieve the tension will give free exit to the pent-up matter, and limit the suppurating process. A nourishing diet should be ordered, drugs prescribed to control the necrotic tendency and cleansing washes used to keep the mouth pure. The dead bone is allowed to loosen before its extraction is attempted; when the sequestrum has formed it should be removed through the mouth. In all operations on

the lower jaw it is proper, if possible, to preserve the periosteum, that reproduction may follow.

**Epulis.**—This term, from a scientific point, has no significance. It is employed to indicate a tumor of the gum, without definite meaning.

**Fibrous Tumors of the Gum.**—(A form of epulis). These usually spring from the periosteum of the alveolar border. The growth is slow and painless, presenting a round, smooth appearance, elastic to the touch and of the color of the normal mucous membrane. As the tumor advances it may press upon the adjacent teeth so as to displace them. It has no tendency to undergo cystic degeneration and is not liable to recurrence after its removal. It has been known to become sarcomatous.

**TREATMENT.** The only rational method of treatment is operative. The alveolar process should be cut through with a sharp chisel or saw, on either side of the tumor, from above downward to a depth below the area of affected tissue, then with appropriate forceps the intervening alveolar process, including the tumor, is snipped away. In mild cases a thorough curetting is all that is necessary.

**Epithelioma of the Gum.**—It usually begins near the stump of a carious tooth, though it may develop at any point that is irritated. It first appears as an induration, with an eroded or ulcerated surface. The adjacent tissue rapidly becomes infiltrated and the disease extends along the mucous membrane, involving the cheek on one side and the tongue on the other. Pain is a prominent symptom, and an early involvement of the lymphatic glands is characteristic. In all epitheliomatous growths of the mucous membrane of any part of the mouth early glandular enlargement to an extraordinary degree is the rule, though the initial lesion may be small. This fact is so patent that wherever the cervical lymphatic glands in a patient past the middle age of life become affected and progressively enlarge a careful inspection of the mouth and fauces should be made, with a view of locating the primary epitheliomatous ulcer, which may be insignificant in size. The disease appears on the mucous membrane covering the gums of the lower jaw more frequently than on that of the upper. The alveolar process is rapidly destroyed, and the compact bone eroded. When the gums of the maxilla are the seat of the lesion, as the alveolar process is destroyed the antrum is opened and a deep, foul chasm is exposed. The disease runs a rapid course and terminates fatally in from six to eight months.

**TREATMENT.** In the early stages a liberal excision of the gums and alveolar process should be made, as recommended in fibroid tumor of the gums. In the advanced cases great courage and surgical skill are required in the execution of the operation. A flap should be reflected back from the cheek and the dissection carried in every direction into healthy tissue. It may be found necessary to sacrifice the eye and other important structures, in order to remove all the morbid products. Though the operation may be extensive and thorough recurrence and ultimate death are the rule.

**Sarcomata of the Jaw.**—Sarcomatous growths arising from the jaw are usually classed as malignant epulis, myeloid epulis, etc. Myeloid sarcoma in connection with the alveolar processes is a rare occurrence. Sarcoma of the gum is usually connected with the socket of a tooth, and



projects into the space between the teeth and the cheek. The tumor is very vascular and grows rapidly.

**PERIOSTEAL SARCOMATA OF THE JAW.** These are of the round-celled or spindle-celled variety; they arise more frequently in the upper than in the lower jaw, and are rarely found before the age of fifteen years. They may start in any part of the mandible, either the ramus or the body. In the maxilla they seldom start from the facial side, but the muco-periosteum of the antrum is the frequent seat of origin, from whence they encroach upon the nasal cavity, sphenomaxillary fossa, and sometimes press upward and displace the orbital plate, giving to the eye a peculiar prominence. When the bony walls have been destroyed by absorption the tumor grows rapidly, distorting the features. While pain in these neoplasms is not usual in the early stages it becomes a prominent symptom later.

The diagnostic differentiation must be made between this and benign tumors. Rapidity of development, invasion of adjacent structures, and an early involvement of lymphatic glands are points of especial value. Treatment is by removal. The prognosis is always unfavorable, as a reproduction of the growth is almost certain to follow.

**Enchondroma.**—This is rarely encountered in the jaw. The disease appears in early life, usually as a tumor of the antrum or the body of the lower jaw. It is hard, with a smooth surface, of slow growth and not attended with pain. The deformity resulting from its presence is frequently excessive.

**TREATMENT.** The tumor, in conjunction with the subjacent bone, should be excised. There is a tendency to recurrence.

**Osteoma.**—Osteoma of the jaw is of less frequent occurrence than either fibroma or enchondroma. It is a simple thickening of the entire bone, or an out-growth from it. It usually springs from either the anterior surface of the jaw or the antral wall. The tumor is densely hard, of slow growth and not generally productive of great pain.

**TREATMENT.** This is by removal.

**Dentiferous Cysts.**—These develop in connection with the teeth, the result of some chronic irritation; they may also be due to an error in development. From some cause one of the permanent teeth remains undeveloped—a supernumerary tooth may serve as the starting point. The fluid which normally collects between the enamel of the organ and surrounding tissue forms a cyst in the substance of the bone by its gradual accumulation. The tooth, having an etiological relation to the developing cyst, may grow in a wrong direction, or may be misplaced and entirely covered by bone; it always projects into the cyst and may ultimately become free. The cyst wall is lined by a thick, vascular membrane. The tumor occurs in young subjects and is of slow and painless growth; it is smooth and uniform in its contour, and develops mostly toward the outer side of the jaw. An examination will show that one of the permanent teeth is absent, or that its place is filled by a temporary one. The development and character of the tumor will indicate the condition. The diagnosis is made by an exploratory incision.

**TREATMENT.** Treat by free incision with the knife or chisel, and removal of the misplaced tooth. The operation should be performed through the mouth. The cavity, if large, should be washed daily with



an antiseptic solution and packed with sterilized gauze until it fills with granulations.

**Sub-Periosteal or Dental Cysts.**—These cysts develop in connection with fully formed teeth, and are the result of some chronic irritation at the root of a tooth. They grow from beneath the lining membrane of the alveola. The pressure from the gradually expanding cyst causes absorption of the surrounding bone and consequent displacement of adjacent structures. The contents of the cyst are usually clear, with more or less admixture of serum. The growth of the tumor is slow and painless, and the attendant symptoms are unimportant.

**TREATMENT.** Free incision and the removal of any source of irritation are required. The cavity should be cleansed daily and packed with gauze until granulation is complete.

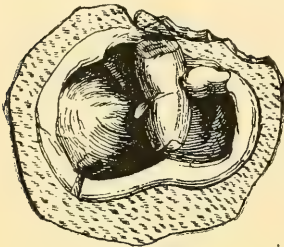


Fig. 551.  
Follicular Odontome (del-  
tigerous cyst). The tooth has  
a truncated root.—Sutton.

**Odontomata.**—“An odontome is a tumor composed of dental tissue in varying proportions and different degrees of development, arising from a tooth-germ or a tooth still in process of growth.”—Sutton. (Figs. 551, 552, 553.)

As shown in the preceding section, a displaced tooth may cause a cystic formation; likewise, an histological perversion in the development of a tooth may give rise to an osseous pathological product; it also happens sometimes that a tooth may develop in an abnormal location.

These tooth tumors may be outgrowths from perfectly formed teeth—coronary odontomes. They may arise from an abnormal development of all the elements of a tooth germ, in which the tumor consists of hard masses of cementum and dentine, irregularly distributed—bulbar or composite odontomes. Or the growth may spring from the papilla, while the roots of the tooth are in the process of formation, after the crown has been formed, the outer layer of which is composed of cementum; within this is a layer of dentine, and inside of this is calcified pulp—radicular odontomes.



Fig. 552.  
Bulbous Odontome,—Forest.



Fig. 553.  
Radicular Odontome.

The symptoms to which these tumors give rise are indefinite. Unless there is a protrusion through the gum there is no data upon which to base an opinion, therefore the condition has seldom been diagnosed. Sometimes the condition has been mistaken for malignant growths and a large portion of the bone has been cut away. In case of a slowly developing tumor in young adults the surgeon should be on his guard, and an exploration of the tumor be made before portions of the jaw are sacrificed.

**TREATMENT.** The growth, together with the tooth involved, should be removed by enucleation and the cavity allowed to fill by granulation.

**Diseases of Temporo-Maxillary Articulation.**—This articulation is subject to many of the diseases that affect other joints, though it is not frequently the seat of such disorders. Inflammatory conditions of the lower jaw, or any of the adjacent structures, may extend to the articulation and produce a soreness or a stiffness in its movements. Tumors of the parotid, pharynx, or soft palate may interfere with its action. Acute inflammation of the parotid and cervical glands, or of the tonsils, and inflammatory exudations in the areolar tissue about the face and neck may cause pain and also limit the motion of the jaw.

Spasmodic conditions of the masseter muscles sometimes attend the eruption of the wisdom teeth, which will be found to be either misplaced, pressing forward against another tooth, partially covered by a portion of the gum, or surrounded by a zone of ulceration. The contraction disappears under the lethal influence of an anesthetic, when the mouth can be easily examined and the offending tooth extracted, giving prompt relief. If the spasms are of an hysterical nature they suddenly return after the patient emerges from the influence of the anesthetic.

Rheumatic arthritis sometimes attacks this articulation and when the disease becomes chronic in its nature may produce such changes as interfere with the free motion of the joint. The intra-articular cartilages are absorbed, and there is an out-growth of bone in the joints that forces the chin forward, creating more or less deformity. If the disease is unilateral the chin is pushed to one side.

Fibrous adhesions in the articulation, resulting from suppurative arthritis consequent upon tubercular diseases, injuries and suppurative conditions, cause the most serious and intractable forms of ankylosis. Cicatricial contractions of the soft structures are also productive of permanent closure of the jaw. They may arise from gunshot wounds, destruction of tissue from suppuration after scarlet fever, sloughing of the cheek from cancrum oris, mercurial poisoning and the contractions incident to surgical operations.

**TREATMENT.** The condition of maxillary immobility is among the most perplexing that the surgeon is called upon to relieve. In those cases caused by muscular and cicatricial contractions the subcutaneous division of the contracting bands by multiple incisions, followed by gradual stretching, will sometimes give good results. But when the cicatrices are extensive and the contractions strong this method of treatment will prove unsatisfactory, and other means will be required. Many surgeons speak highly of Esmarch's operation for the relief of the condition. In this operation a wedge-shaped piece of bone is removed from the horizontal portion of the ramus (Fig. 554) for the purpose of establishing a false joint. The section is made anterior to the masseter muscle. An incision two inches long is carried along the lower margin of the jaw, in front of the angle. After exposing the bone and dividing the

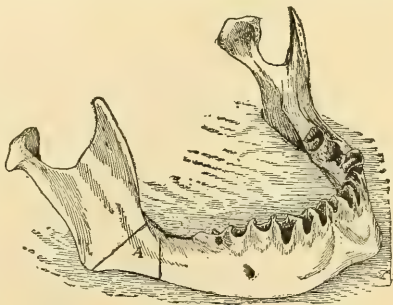


Fig. 554.  
Wedge-shaped Excision of Portion of Ramus of Jaw for Artificial Joint in Ankylosis of Temporo-Maxillary Articulation.



periosteum, it is cut through with the saw and chisel. The wedge removed should have its base, which measures one inch, downward, and its apex, half an inch in length, at the alveolar border. After the bleeding has ceased the wound is closed with sutures and a dressing of gauze, sustained by a bandage, applied. Passive motion must be instituted within a few days after the operation and continued daily. The patient should be encouraged to open the mouth as wide as possible, and if necessary be supplied with a screw or a wedge-shaped gag for the purpose.

Fairly good results usually follow the operation, though one-sided masticatory power is obtained.

When ankylosis exists excision of the condyle is necessary. It is also indicated in some cases of suppurative diseases of the joint. The operation is sometimes difficult to perform.

An incision one and one-half inches in length, beginning at the lower margin of the zygoma, just in front of the temporal artery, is carried downward over the condyle. The first cut includes the skin and subcutaneous cellular tissue. The temporo-facial branch of the seventh nerve is sought and pulled forward, the lobes of the parotid pushed aside, and the capsule of the joint opened. The neck of the condyle is now steadied by means of a blunt hook, and divided with chisel or saw. The head is then seized with forceps, detached with scalpel and pried out. It is important that in all the manipulations the instruments be kept close to the bone. A small drain should be introduced, the wound closed, and a dressing of antiseptic gauze applied. The drainage may be removed in twenty-four to forty-eight hours. The same after-treatment recommended in Esmarch's operation must be carried out, to prevent a relapse. Some slight facial paralysis follows the operation. The results are usually good.

An ankylosed lower jaw is liable to grow less slowly than the upper; therefore a noticeable deformity will exist. After an operation faridization and massage will greatly aid in restoring the lost power to the atrophied muscles. Some cases of impaired mobility do well after operative procedures, but it must be borne in mind that in a majority of cases relapses will occur and the functional activity of the jaw be again destroyed.

**Odontalgia.**—(Toothache.) This term literally denotes a pain in a tooth, whether from general or local causes. The irritation may be the result of a morbid state of the general health, a reflex manifestation, or it may be due solely to a pathological lesion in the tooth itself. To attempt to treat the subject in its entirety would occupy more space than can be allotted to any one topic in this section; therefore the latter condition only will receive attention. Dental caries probably constitutes the most frequent cause of toothache. Caries consists in a chemical disintegration of the elements of the tooth through germicidal action. Pits, fissures, irregularities, surfaces of adjacent teeth that are in contact—in fact, any condition that shields a surface from the washing of saliva which is antiseptic in nature, or the friction of the tongue and lips in their various movements—permit a deposit of foreign matter, such as particles of food, and furnish a lodgment to micro-organisms. When a colony of organisms is established a fermentative process is also established



and lactic acid is produced, resulting in the decomposition of the enamel and its penetration. When the enamel is once destroyed the fungi penetrate the dental tubules and disintegration of the histological elements of the tooth goes rapidly on.

Caries is often the cause of severe and persistent toothache. If the caries is superficial the pain may be due to a hyper-sensitive condition of the dentine or to an increased vascularity of the pulp. Where the caries is deep the pulp may be exposed when the pain is severe and lancinating.

Pulp-exposure often causes continuous aching, though at times it is temporary and intermittent in its nature. A congested and inflamed pulp without exposure in a tooth free from decay is attended with persistent and throbbing aching, which is aggravated by movement and by the horizontal posture. The bony casement which contains the hyperemic pulp, owing to its unyielding nature, causes the pain and consequent putrescence or death of the pulp. The evolution of gases incident to decomposition in a putrescent pulp often causes the most excruciating and continuous toothache. The tooth, highly sensitive, seemingly becomes elongated, which adds greatly to the suffering. Unless a free exit is given to the pent-up gases suppuration and an alveolar abscess follow.

Periodontitis, or inflammation of the peri-dental membrane, causes pain of varying character. It is not usually severe in type, but unremitting in its nature, and is commonly denominated a "grumbling toothache." When the exciting cause is a putrescent pulp the pain takes on the severity and characteristics that belong to that pathological lesion.

**Nodular Dentine.**—This condition, developing in the pulp chamber, owing to the unyielding nature of the walls, is at times the cause of local pain which is usually periodical in character, the patient experiencing perfect comfort between the paroxysms. The nodular masses are frequently productive of reflex irritation; the terminal nerve filaments in other branches of the fifth nerve being the seat of neuralgic pains.

**Excementosis.**—An abnormal activity of the peri-cemental tissue resulting in a thickening of the cementum is often productive of local pain.

**TREATMENT.** Toothache arising from superficial caries or sensitive dentine may be relieved by first syringing the cavity with warm water, then drying it with a pledget of cotton, after which an application of finely pulverized nitrate of silver may be made. This should be allowed to remain for a few minutes, keeping the cavity dry in the meantime, when it should be again syringed. The surface turns dark but the sensitiveness is promptly relieved. Another efficient remedy is equal parts of tincture, iodine and carbolic acid, applied by means of a pledget of cotton. The cavity should then be closed with bees-wax. These cases should be referred to a dentist, as the proper filling of the cavity will permanently relieve and save the tooth.

When pain originates from a diseased pulp, whether partially or completely exposed, the cavity should be cleared of all offending matter, both with an instrument and by syringing with warm water. This will frequently be all the treatment necessary, but if the pain continues, which will indicate a congested condition, a mixture of equal parts of chloroform, aconite and laudanum may be applied by means of a pledget of cotton.

Another reliable prescription is:

R

Atropiæ sul. gr. ....vj

Aq. dest. ....f ʒj.

M. S. Apply as above.

When a dead or putrescent pulp is the cause of the symptoms the pulp chamber should be opened and the gases and decomposing products allowed to escape.

An inflammation of the peri-dental membrane, peri-cementitis, may be produced by various lesions of the tooth, such as wounds, contusions, fracture or the product of a disintegrating pulp passing through the apical foramen; therefore the pathological condition superinducing the pain may be complicated and demand special treatment for its relief. If the exciting cause is not removed an alveolar abscess may result. Patients so afflicted should always be referred to a competent dentist.

To alleviate the suffering hot applications may be applied to the side of the face and neck by means of cloths wrung out of hot water, a hot water bag or a sack filled with hot salt. The hourly administration of hepar sulphur second, in two to three grain doses, will at times prove beneficial. For a local anesthetic the following may be applied to the mucous membrane:

R

Cocaine hyd. gr. ....vj.

Chloral hyd. ....

Gum camphor aa gr. ....lxxxv

M. Trit. in mortar until liquefied.

This mixture will be found highly beneficial as a local application in almost any of the forms of odontalgia, the result of local causes.

Granules of ossified dentine in the pulp chamber and excementosis are conditions difficult to diagnose and usually require extraction for their relief.

In many cases of toothache, in which the pathological changes are not of an advanced character, the properly indicated remedy internally will afford prompt and satisfactory relief.

**Extraction of Teeth.**—There is nothing in the practice of medicine that should be more harshly condemned than the indiscriminate extraction of teeth. The injuries entailed by the loss of the teeth are so multiform, the evil influence so far-reaching, that one should never be sacrificed without due consideration. When a tooth becomes so badly diseased that it is no longer amenable to treatment, and its presence is a menace to comfort and health, it should be removed, as should also those which by their presence are liable to excite serious disorders of adjacent structures. At times it is proper to extract teeth to prevent or correct irregularities.

The deciduous teeth should rarely be removed until the permanent ones have nearly approached the surface. If decay or disease of any kind attacks them before the proper time of their exfoliation they should receive attention at the hands of a competent dentist, the same as the permanent teeth.

In order to make a proper investigation of the teeth when deciding upon the propriety of removal the operator should possess a syringe for the application of hot and cold water and an instrument with which he

can make percussion upon the body of the tooth and the necessary explorations for decay in the cavities, or to ascertain the condition of the roots. The point of origin of pain, when caused by a diseased condition of the dental pulp, is at times difficult to locate. The function of the dental pulp in a fully developed tooth is to convey thermal impressions; under normal conditions it has no other, while the peri-dental membrane possesses tactile sense. When the dental pulp is diseased in an otherwise sound tooth it is peculiarly sensitive to heat and cold but not to percussion. While inflammation of the peri-dental membrane, when the pulp is not involved, does not represent the application of heat or cold it is very sensitive to percussion. These facts should be well borne in mind when making a differential diagnosis in such cases between diseases of the dental pulp and peri-cementitis. A painful response to percussion indicates either a dead pulp, with resultant abscess due to decomposition of pulp, or peri-cementitis; if, however, there is no sensitiveness to percussion in an aching tooth that is decayed an exploration of the cavity will reveal, through its tenderness, an exposed pulp.

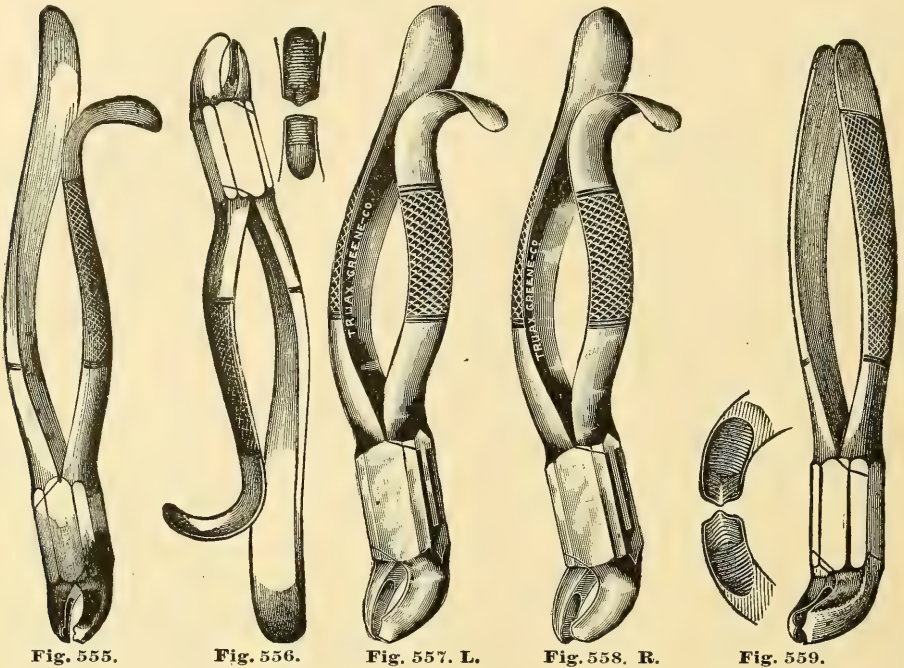
It sometimes occurs that two teeth in the same space are decayed, and in such instances it may be somewhat difficult to decide as to the one that is causing the pain. The acute pain excited by the exploring instrument, when it comes in contact with the highly sensitive dentine, will reveal the one that is at fault. It sometimes happens that a tooth which is apparently sound is painful. If, after a careful search, no cavity is detected, no response to percussion, and no sensitiveness to the application of a jet of either hot or cold water, an examination should be made for a decaying wisdom tooth (*dens sapiens*) and if one be found that is carious in either jaw it should be extracted, when the pain will disappear. At times the pain from an offending tooth is reflected to one or more in the opposing jaw, therefore, if an inspection fails to reveal a diseased tooth in the region of pain, the corresponding tooth just above or below the one complained of should be examined, to make sure of pulling the right one. When a patient complains that a tooth is very sore, feels longer than the others, and when the face is swollen an alveolar abscess probably exists, which has broken through the bony walls. (Treatment of Alveolar Abscess, page 836). The soreness is not likely to increase, but will soon subside. If the tooth is extracted during the stage of tenderness the pain attending the operation will be very severe, and the suffering will continue for some time. On the other hand, if the tooth is left undisturbed until the soreness is relieved its removal can be accomplished with but slight discomfort. When the pulp of a tooth is exposed the pain is lancinating and intermittent; under such circumstances the extraction of the tooth is usually followed by immediate relief.

For the proper extraction of teeth, the physician should possess, at least, five pair of forceps; three for the upper and two for the lower teeth. Only one instrument is required for the removal, in either jaw, of the incisors, cuspids and bicuspid. For the upper, that illustrated by (Fig. 555) and for the lower, (Fig. 556) will answer well. The upper molars demand a forcep for each side of the mouth, (Fig. 558, R. and Fig. 557, L). while for the lower but one is necessary, (Fig. 559.)

The roots of the upper incisor and cuspid teeth are conical, and are best loosened by a rotary motion. Taking the forcep (Fig. 555) in the



right hand, its beak is pressed well up under the gum and the tooth so firmly grasped that the instrument will not move upon it, then with a slight rotary or twisting motion from right to left the tooth is detached



from its socket; it may then be removed without force. The bicuspid are extracted with the same instruments, but as they have two roots they should be freed from their attachments by an in-and-out movement. After being loosened they can be with-drawn by a straight pull. The roots of the second bicuspid are generally flattened, therefore they are extracted in the same way as the former.

The upper molars, having three roots, are best extracted with forceps R and L (Fig. 557-8). The force is applied in the same direction as is required for the bicuspid, but, owing to the fact that the teeth are set in an arch, the major part of the force should be applied toward the labial or outer side of the jaw. The upper wisdom teeth are usually extracted by a backward and outward pressure, thus turning them toward the cheek.

The lower incisors have their roots flattened antero-posteriorly, therefore they are most readily extracted with forceps (Fig. 556), by a backward and forward force, but a very slightly rotary motion will frequently aid in loosening them. The lower cuspids and bicuspid are extracted with the same instruments, but with the force applied in the same manner as directed in the removal of the upper cuspids.

The lower molars have usually two flat roots; in extracting them forceps (Fig. 559) should be applied so that the beaks, when the handles are compressed, will enter between them. With an outward and inward motion, the greater force being applied in the outward direction, they are readily removed.

The lower wisdom teeth are often the most difficult of all to extract. They sometimes present the masticating surface against the posterior surface of the second molar, while the roots run backward into the ramus of the jaw. It often requires skillful manipulation to remove them; sometimes it becomes necessary to draw the second molar before their removal can be accomplished.

**HEMORRHAGE FOLLOWING TOOTH EXTRACTION.** The extraction of a tooth is occasionally followed by free and continued bleeding, which, in some cases, becomes so alarming that the aid of a physician is required to control it. The hemorrhage may result from a constitutional dyscrasia, or it may be produced by the local injury sustained in drawing the tooth. The gums may be severely lacerated and the blood vessels torn, or the bony wall of the tooth socket fractured. In the first instance, when it is known beforehand that the patient is of hemorrhagic diathesis, the extraction of the tooth should be delayed until the constitutional condition is improved by the administration of appropriate remedies. On the other hand, if the bleeding is caused by a fracture of the alveolar process the fragments of bone should be removed and the strips of torn gum clipped away with the scissors. The cavity should then be cleansed and firmly and evenly packed with fine lint or a narrow strip of gauze, producing gentle but continuous pressure. No other means will give as satisfactory results as perfect coaptation of the parts and pressure; at times it may be necessary to first wash out the cavity with a strong tannic acid solution. If the pressure fails to accomplish the result the lint may be impregnated with powdered tannic acid, and the cavity again packed with it. If the tannic is not at hand pulverized alum may be used in its place, or the cavity may be syringed with a strong solution of the drug. In the absence of other agents oil of turpentine may be used; besides being a fairly good styptic it is antiseptic and tends to relieve the soreness. The application of cold may at all times be of value; the patient may be directed to sip iced water, hold small pieces of ice in the mouth, or the cavity may be irrigated with a stream of cold water. The well known styptic properties of heat may be utilized; at times it will be found to be more efficacious than cold. A stream of water, as hot as can be borne, may be projected against the bleeding surface. It should be continued for several minutes. The galvano—or Paquelin cautery—at a dull heat may be applied. If the patient is of a hemorrhagic diathesis it may be necessary, if other means fail, to scar the parts with the cautery heated to a cherry red. If all other means prove futile, before the patient should be allowed to perish from exhaustion the carotid should be ligatured.

## CHAPTER V.

### MALFORMATION OF THE PHARYNX.

**General Considerations.**—In fetal development the epiblastic layer which forms the mouth meets and invaginates the hypoblastic layer coming up from the alimentary canal. A failure in the proper involution of these embryonic structures results in a malformation of the pharynx, producing occlusion, stricture, etc.



Fig. 560.  
**Pharyngeal Diverticulism.**  
(After Morrison Watson.)

“Diverticula may originate in the same way. Some of these are acquired (Pharyngocele), a part of the wall is weakened by inflammation or injury to such an extent that the mucous membrane bulges out through the opening; the larger ones however, and especially those that occur in the region of the inferior constrictor, are congenital in origin (Fig 560). When small they are not noticed; as they increase in size they form a pear-shaped swelling by the side of the neck, pressing upon the great vessels, displacing the larynx and often causing dyspnea and

violent fits of spasmodic coughing from pressure upon the superior laryngeal nerve. The nature of the sac is easily recognized at different times from the way in which its contents—air and sodden food—are returned into the mouth when it is subjected to external pressure, or squeezed by the muscles around it. As it enlarges it displaces the esophagus, becoming more vertical and drawing nearer the middle line until the natural passage is thrust entirely out of its axis. In one of these cases Wheeler laid open the tumor from the outside, excised it and successfully secured the margins of the opening with sheep-gut suture.”—(Moullin).

**Fistulæ.**—In the human embryo there are four brachial clefts, one or more of them often forming cysts. The orifices of these congenital canals are known as fistulæ; they open along the side of the neck at a point between the hyoid bone and thyroid cartilage opposite the thyroid cartilage and near the sternal end of the clavicle. When the canal is complete they also open into the pharynx, sometimes allowing liquids to pass down through on the neck. It is reasonable to suppose that they may open into the pharynx, ending externally in a blind pouch, forming a retentive cyst or diverticulum filled with the secretions from the mucous lining of the canal. Fig. 561 shows the external opening of the clefts. The orifices are



Fig. 561.  
**Orifices Persistent Brachial  
Fistulæ.**



minute, scarcely admitting the point of a fine probe. The tract is lined with a membrane that secretes a white, viscid mucus, which is at times intermittently discharged. From a surgical standpoint these fistulous tracts are usually of minor importance; they may sometimes be cured by exciting a degree of inflammatory action sufficient to destroy the secreting membrane; when causing disorder or inconvenience they have sometimes been dissected out. The operation is a tedious one, as the canals course along the carotids and lie in close proximity to other important structures.

**Papillomata.**—Warts of the soft palate, uvula or pillars of the fauces are frequently observed. These growths usually develop on the tip of the uvula or the pillars of the fauces. They present the same appearance as warty growths on other parts of the body, only they have a more purplish color and produce but slight disturbance, often going unnoticed by the patient. Their removal is accomplished with the scissors or the cold wire snare. In cutting them away the base should be removed beneath the mucous membrane.

**Fibroma.**—This form of neoplasm is seldom seen in the fauces. It is sometimes found imbedded in the soft palate or the pillars. It is not different from similar growths in other parts of the body. The tumor develops rapidly and gives rise to much faucial disturbance. If small it may be removed by enucleation through an incision in the mucous membrane, but if of large size external operation may be demanded.

**Angioma.**—True cases of angiomata have been found in the fauces; they are formed by a net-work of blood-vessels, bound together by connective tissue and are highly sensitive, giving rise to a great amount of irritation. The tumors present a soft, vascular appearance and are purplish in color. The treatment is removal by the galvano-cautery.

**Adenoma.**—This form of neoplasm is frequently seen on the soft palate. The origin of the growth, it is said, is an obstruction of the orifice of one of the muciparous glands, resulting in dilatation and hypertrophy of the glandular structures. "The frame-work of the tumor is made up of delicate stroma of connective tissue supporting a large number of acini. The spaces between these acini are filled in with lymphatic tissue." The growth develops slowly and gives rise to but slight disturbance until a notable size is reached. The symptoms are much the same as when other growths occupy the region. The distinguishing difference between this and fibroma is difficult to define, but may be cleared up with the microscope. The tumor is amenable to operative treatment, the same rules applying here as in fibroma.

**Sarcoma of the Pharynx.**—Sarcoma occurs usually between the ages of thirty-five and fifty. The majority of cases are developed in the male. The pathological features of the disease here do not differ from those of other regions of the body. The growth has but slight tendency to extension, or the involvement of other organs, and is said to be quite amenable to operative treatment.

The symptoms present no striking characteristics until the disease begins to produce functional disturbance. The tumor may grow to such a size that deglutition and respiration are greatly interfered with. It is nodulated, pinkish or dark purplish-red, and covered with large, tortuous veins. As the growth increases in size it becomes pedunculated; a microscopical examination of a section of the tumor confirms the diagnosis.

**TREATMENT.** The treatment is by excision. The tumor should, if possible, be removed through the natural passage. If encapsulated it can be shelled out with the finger; if pedunculated it should be cut away with the scissors and the base destroyed with the galvano-cautery. Circumstances may arise where a preliminary tracheotomy or ligation of the carotid artery will be necessary and the tumor must be removed by an external incision. If the adjacent glands are affected they should be removed at the same sitting.

**Carcinoma of the Pharynx.**—Carcinoma of the pharynx is of rare occurrence. The disease is found to exist more frequently in the female than in the male. Epithelioma is the prevailing type; it rapidly develops to ulceration and has a tendency to extend downward. The cervical glands soon become involved. In the earlier stages the symptoms are not well marked, but as the disease extends the functions of the pharynx are interfered with and the salivary secretions increased; hemorrhage and pain accompany the spread of ulceration and cachexia is early pronounced. The ulcerating surface is of a dirty-gray color and covered with bloody secretions from the capillary oozing. The microscope confirms the diagnosis. The disease is grave in character and early in its history shows its fatal tendency, as it runs its course in from six to twelve months. Owing to the fatal tendencies of the disease operative treatment is of but little avail. If the entire growth can be extirpated it should be accomplished, preferably by the external method. It may be advisable at times to excise portions of it to relieve functional embarrassment. The scissors or wire snare may be used for this.

**Uvula.**—Elongation of the uvula is a condition of frequent occurrence and often requires surgical interference for its relief. The normal uvula is about one-third of an inch long; when diseased it may reach the extreme length of three-fourths of an inch, resting upon the base of the tongue and exciting a most distressing cough. The cough is usually dry and irritative, rather of a nervous character, and generally aggravated when lying on the back, at which times the uvula rests against the posterior wall of the pharynx. The condition has at times given rise to severe affections, such as asthma, laryngeal hoarseness and bronchial irritation. The pendulous member is seldom hypertrophied laterally; the growth seems to extend downward; it is always aggravated during acute attacks of cold.

Diagnosis is made by a visual inspection of the fauces.

While the remote effects of an elongated uvula may be serious, the condition itself is never dangerous.

**TREATMENT.** Temporary relief may be obtained by the local application of astringents. The region may be brushed over with a strong solution of alum, tannin, iron or nitrate of silver; hyoscyamus, belladonna and mercurius are the internal remedies that will most frequently meet the indications. In acute uvulitis, where the uvula presents an edematous condition (Fig. 562) rhus tox. will often give prompt relief.

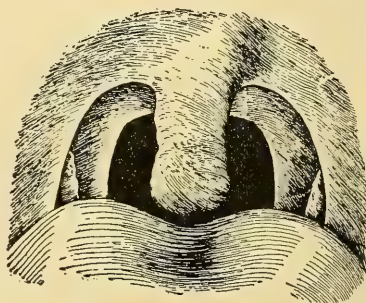


Fig. 562.  
Acute Uvulitis.



The only treatment that offers permanent cure in chronic elongation is excision of the offending member. Many forms of scissors are manufactured for this purpose, but the operation is best done with a pair of curved scissors. The tip of the uvula is seized with a pair of long slender forceps and drawn well forward and held while it is cut away with a clip of the scissors at an angle from before, backward and upward. In seizing the uvula care should be taken that the muscular tissue be included in the grasp, otherwise the mucous membrane will be drawn down and excised, veritably skinning the muscle and thereby leaving a large raw surface. Hemorrhage after uvulotomy is of rare occurrence; should it follow the operation in any degree of severity the parts can be seared by the galvano-cautery. Usually a marked degree of soreness results and the patient will be compelled to live on broths and soup for a few days, as every attempt to swallow produces pain which is greatly aggravated by the contact of solid food of any kind. The constant action of the pharyngeal muscles excites a great degree of suffering, considering the insignificance of the operation. Therefore when the patient is undergoing any treatment for diseases of the throat or nose in which it is necessary to remove the uvula the operation should be postponed until the last, for it is often that owing to the suffering entailed the patient will not return to finish the treatment.

**Lupus of the Fauces.**—When lupus invades the fauces it is usually of secondary development, having previously existed on some external part of the body. The soft palate seems to be its favorite pharyngeal seat. The disease gradually extends from the point of primary infection to adjacent structures, destroying the parts by ulceration and distorting them through cicatricial contraction. In the beginning there is an infiltration of tissue, with the characteristic thickening and impairment of vitality. The ulcerative process that ultimately follows is slow but progressive in nature and yields but slight secretion of pus. The disease is of a tubercular character, propagated by the tubercle bacilli, and bears a kindred relation to tubercular diseases of other parts of the body.

**DIAGNOSIS.** The diagnostic features are marked chronicity, characteristic infiltration, ulceration and deformity. The microscope yields confirmatory evidence.

**TREATMENT.** There can be no doubt of the highly satisfactory results obtained by excision of the diseased area. The operation should be thorough, and every particle of infected tissue should be removed, otherwise the results will be disappointing. Curetting does not yield satisfactory results here. When the process is so extensive as to preclude the use of the knife other modes of treatment may be tried. As a local measure the galvano-cautery probably stands first. The entire diseased surface should be deeply seared with a broad knife-electrode. If this does not arrest the advance of the disease a second or third application should be made after the eschar is cast off. Nitrate of silver as a topical application, in the strength of two to four drachms to the ounce of water, is highly recommended by some writers. Strong solutions of the perchloride of iron and iodine are remedies that have also been used with variable degrees of success. Owing to its successful application in tuberculosis of the larynx, lactic acid has been suggested as a curative agent. The patient should be placed on a nutritious diet and cod liver oil; and



such remedies prescribed as arsenicum, arsenicum iodatum, calcarea and calcarea iodata. There is no doubt but that the long continued internal administration of arsenicum in the 3x will have a beneficial influence in some cases of lupus, and cases have been reported cured by its local and internal use, the 3x internally and 2x locally.

**Peritonsillar Abscess.**—The areolar tissue surrounding the tonsil is frequently the seat of violent inflammation that often develops a phlegmon. It usually attacks patients who are the subjects of chronic follicular tonsillitis, and is generally preceded by an acute development of that disease. The presence of micro-organisms that exist in the crypts of the diseased gland renders infection easy and possible. The tissue that forms the tonsil being largely lymphatic in character, the pathological germs are readily taken up and conveyed to the adjacent structures, which are in nature adapted to the development of the suppurative process.

The affection may be classed among the diseases of middle life. Childhood is peculiarly exempt from it and the atrophy which the tonsils undergo in later life renders such subjects less liable to infection, though a remnant of diseased tonsil may propagate the disease in old age. Heredity plays an important role in the etiology of the disease. Rheumatism is considered a predisposing cause and exposure to cold the most frequent excitant.

The attack begins with a stage of chilliness, accompanied and followed by fever of more or less intensity, which sometimes attains an elevation of 105 degrees. The febrile disturbance is attended with a feeling of general distress, headache, pain in the bones and sometimes nausea and vomiting. Within a few hours of the initial attack the patient begins to experience a feeling of fullness and discomfort in the throat, which soon develops into a deep, aching pain, aggravated and rendered sharp by every effort of swallowing. The subjective symptoms are so well marked that the physician's attention is promptly directed to the local manifestations of the disease. Upon an inspection of the fauces the structures are found to be greatly congested, swollen and edematous. The exudation in the areolar tissue about the tonsil causes it to bulge and present a high degree of prominence, though the tonsil may be but slightly affected. The salivary secretions are excited, the voice grows husky, and deglutition, as the disease advances, becomes at times well nigh impossible. The aching pain assumes a darting character and may extend to the ear; hearing is impaired and the sense of taste and smell abolished. The patient is restless, sleep is denied him, and if the trouble continues for several days mild delirium may supervene.

A diagnosis is made by an inspection of the fauces, which present all the features of an active inflammation. The tissue about the tonsil is greatly tumefied, bright red or purplish in appearance. (Fig. 563). The presence of pus is ascertained by palpation with the index finger. This should be carefully and gently done, as the sensitiveness is extreme. The

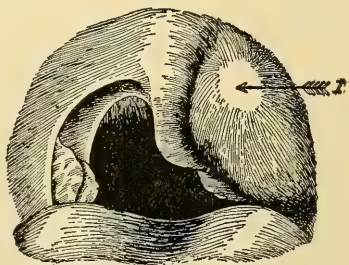


Fig. 563.

1 Point for Incision Palatal Tonsillitis.

disease runs its course in from five to ten days, and while the patient suffers great discomfort it is not usually attended with danger, though serious complications may arise, such as edema of the glottis, burrowing of pus, pyemia, thrombosis, erosions of blood vessels, asphyxia from rupture of the abscess, etc. Pus here, as in other regions of the body, burrows in the direction of the least resistance; therefore the morbid products may discharge at different points, according to the seat of the phlegmon. The opening may occur through one of the tonsillar crypts at the upper internal border of the gland or at its lower posterior aspect.

**TREATMENT.** If the physician is called early a laudable effort should be made to prevent the formation of an abscess. The patient should be confined to his room and made as comfortable as possible. If cold feet and chilliness exist a hot mustard foot-bath should be given, and afterward the feet and legs enveloped in some woolen covering. If the throat feels stiff and dry frequent sips of hot water may be administered and the throat gargled with hot salt water or Pond's extract. If more agreeable to the patient small pieces of ice may be taken.

**MEDICAL TREATMENT.** Aconite, in the early stage, is probably the most frequently indicated remedy. The patient is chilly, sensitive, anxious, restless, skin dry and hot, mouth dry with thirst, throat feels swollen, dry and red, with raw, stinging sensations.

*Belladonna.* Patient irritable and sensitive, face flushed, skin dry and hot, tongue red and dry, throat dry, red and inflamed, with constant aching or shooting pains, throat feels dry and constricted.

*Apis.* Stinging, burning pains in the throat, mouth and throat red and dry, edematous swelling of the fauces, worse in a warm room, thirstlessness.

*Rhus tox.* Characteristic restlessness, drawing, tearing pain, worse from cold, dryness and edema of throat, uvula swollen, looking like a mass of gelatine.

*Baryta carbonica.* Patients of a tuberculous cachexia, who are liable to frequent attacks of tonsillitis. Tonsillitis on right side; after slight exposure, smarting pain on attempting to swallow, a feeling of rawness that is aggravated by any attempt to swallow, a feeling of constriction when swallowing.

*Mercurius.* (Preferably, mercurius biniodide). Moist, clammy skin; tongue broad, thick and coated; profuse secretion of saliva; throat tender with much swelling of the tonsils; burning pain in the throat with feeling of constriction when swallowing; headache, prostration, nightly aggravations.

*Hepar sulphur.* Sensitive to open air, scraping, raw sensation in the throat, sensation when swallowing as if a splinter were sticking; useful when suppuration seems inevitable.

Drop doses of tincture of guaiacum every one or two hours are highly extolled by some of the old school authors, while others equally laud the internal administration of salicylate of soda in five to eight grain doses. The best directed efforts of the therapist will frequently fail to interrupt the progress of the disease, and suppuration will ensue. In order to early recognize the formation of pus frequent digital explorations of the fauces should be made. Having established the fact that pus exists, its early evacuation becomes a question of utmost importance, for immediate



relief is obtained when the abscess is opened and all danger at once subsides. In doing the operation a slender, sharp-pointed bistoury should be selected and the blade wrapped with cotton to within one-half inch of its point. The seat of fluctuation having been ascertained, an incision of sufficient size to admit of the free exit of the pus should be made. If the mouth cannot be opened sufficiently to allow a visual inspection of the parts the index finger of the left hand should be inserted so that its tip will rest against the point of fluctuation, the knife passed along its palmar surface and the incision made in this way. The surgeon must always bear in mind the possibility of wounding the tonsillar, pharyngeal or carotid arteries, and, therefore, make his incision in a cool and calculating manner. If the plegmon is extensive and the patient is a child or a very weak adult the possibilities of strangulation after a spontaneous rupture, from the pus flowing into the trachea, should be explained to attendants and they should be instructed in the matter of depressing the patient's head in order to prevent such an accident. It is often the case that after a quinsy has subsided on one side the other side will become affected and run the regular course or stages of the disease. Since the chronically diseased tonsil is so frequently the source of infection its removal will generally result in a cure. Patients who are subject to recurrent attacks of peritonsillar abscess should have every vestige of the gland removed, also the accompanying rhinitis cured, and be put upon such treatment as their constitutional dyscrasia demands.

**Chronic Hypertrophy of the Tonsils.**—The tonsils are largely composed of lymphatic tissue and are prone to hypertrophy. There are two forms of chronic enlargement of the glands, viz., hypertrophic and hyperplastic. In the first form, hypertrophic, there is an increase in both the lymphatic and fibrous elements, with a notable thickening in the mucous and sub-mucous tissue and an enlargement of the capillary vessels. The crypts are increased in size and are more or less filled with degenerate epithelium and mucus of a cheesy appearance. In the second form (hyperplastic), while there is an augmentation in the number and size of the lymphatic bodies, there is a notable change in the connective tissue that surrounds them. This excessive proliferation of connective tissue has a marked tendency to destroy both the vascular supply and the tonsillar crypts, giving the organ a smooth, rounded and pale appearance.

The disease is usually developed during childhood, dependent upon a diathetic condition, excited by repeated attacks of cold and is usually accompanied with enlargement of the pharyngeal tonsils, hypertrophic rhinitis, and various forms of aural affections. These pathological masses, filling up the faucial gateway, greatly interfere with the physiological functions. The character of the voice is changed, respiration obstructed, digestion and assimilation impaired, with all the consequent evil results. In addition to the general depreciation of health that they cause, the presence of these diseased glands renders the subject liable to all acute disorders of the respiratory organs, and adds to the susceptibility to, and increases the malignancy of, such diseases as scarlet fever and diphtheria. While the disease itself cannot be considered dangerous its consequences are far-reaching and more baneful than any other that affects the life of childhood.

**MEDICAL TREATMENT.** The medical treatment to be successful



must be directed more to the dyscrasia than to the local trouble, and the remedy must be given persistently for months. The principal remedies are baryta carbonica, calcarea, calcarea phosphorica, mercurius iodatus and sulphur. While the administration of medicines will have a beneficial effect upon the general health of the patient the physician who expects to cure the tonsillar enlargement by them will be greatly disappointed. Regardless of existing prejudices against the knife, the removal of the enlarged gland is the most rational and satisfactory method of dealing with it.

**OPERATIVE TREATMENT.** The excision may be performed by the bistoury, the tonsillotome, or the cold wire snare. For one who is deft in the use of instruments the bistoury is to be preferred; the other instruments will not accomplish the results perfectly, as it will not answer to clip the tonsils and remove only the tissue that projects beyond the faucial pillars; for where disposed to acute inflammation this procedure will not prevent a recurrence of the attack.

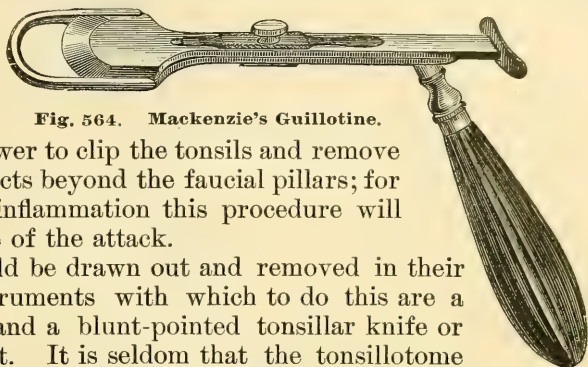


Fig. 564. Mackenzie's Guillotine.

The structures should be drawn out and removed in their entirety. The best instruments with which to do this are a vulsellum or tenaculum and a blunt-pointed tonsillar knife or scissors bent upon the flat. It is seldom that the tonsillotome will accomplish the desired result, for after its use it is often necessary to finish the operation with the knife or scissors. Mackenzie's guillotine (Fig. 564), or some modification of it, is the best form of the instrument, but unless great care is used in drawing the tonsil well out into its grasp with a tenaculum the amount of tissue removed by it will be insufficient. The size of a diseased tonsil is not the criterion as to its removal; so long as it is diseased no matter how small it may be to it is productive of harm, and it should be taken away. The tonsillotome is not adapted to small tonsils, and since in the majority of cases the glands that require removal are small the knife or scissors comes into requisition much oftener than the former instrument. In using the bistoury the tonsil should be caught with a vulsellum or a

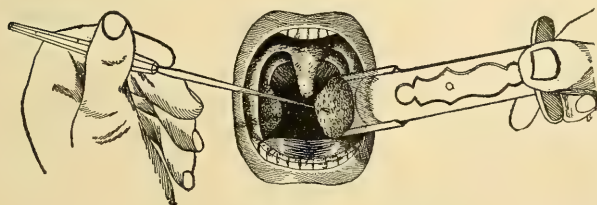


Fig. 565.

Tonsillotomy with Mackenzie's Tonsillotome.

tenaculum, drawn well out and incised close up to its base from below, upward.

If the scissors are used the cutting will have to be done from above downward. If any fragment of the gland remains it should

be caught up and removed. Many tonsils that require taking out are scirrhotic, and any remnant that is left will not disappear through the stimulus of the traumatism, but will remain a source of irritation. If cocaine is used but little pain attends the operation. With a syringe, having a long slender nozzle, a few drops of a four per cent. solution are injected into the crypts that stud the gland, and effectually destroy all sensibility.

Usually but slight hemorrhage follows the operation. If a twig of an artery bleeds it can be checked with the galvano-cautery, or caught with a pair of hemostatic forceps and compressed. If necessary the instrument may be left in the patient's mouth for an hour or two, but usually a pinch or a twist will suffice. If a general capillary or a venous oozing follows, Monsell's solution should be applied with a probe and cotton, or the patient can be directed to slowly sip Mackenzie's tannogallic acid mixture.

R  
 Acid Tan. .... gr. cccx. ....  
 Acid Gallic. .... gr. ccxx. ....  
 Aqua ..... f  $\frac{3}{4}$  j. ....

These failing, the cut surfaces should be seared with the surface of a broad cautery knife.

It is, at times, astonishing to note the effect that the removal of a diseased tonsil has upon the general health. It often changes the patient's condition from that of delicacy to robustness.

The tonsil is liable to be affected with various forms of specific inflammation, as in diphtheria, scarlet fever and syphilis, which may cause various degrees of ulceration or sloughing that may extend to the pillars of the fauces, soft palate and possibly open the carotid.

**Tonsillar Calculi.**—These are of common occurrence. They have their origin in the crypts of the tonsils, and are composed of the phosphates and carbonates of lime and mucus. They usually cause ulceration and are extruded before they attain a large size, though sometimes they distend the gland enormously and require removal. They may be withdrawn with the forceps or enucleated with the finger.

The tumors that affect the tonsils are fibroma, epithelioma and lympho-sarcoma. The fibromata may be removed with the scissors or snare, the epitheliomatous growths are secondary developments and usually not amenable to operative procedures. The sarcomata have been successfully removed, but they rapidly recur. The carotid artery should be tied before their enucleation is attempted.

**Retro-Pharyngeal Abscess.**—A suppurative phlegmonous inflammation of the lower pharynx is designated a retro-pharyngeal abscess. The teaching of former days was that the disorder arose almost always from caries of the cervical vertebræ and occipital bone. Modern writers give to it a more extensive classification of causes.

The disease usually occurs in young children of a strumous habit; at this time of life the lymphatic tissues are in an active state of development and there is a peculiar predisposition to the production of glandular lesions about the neck. Maladies, such as scarlet fever, measles, diphtheria, etc., that are prone to excite morbid action in lymphatic tissue, are prominent etiological factors in the development of the disease. In fact, the point of infection may exist in any of the adjacent organs that have a lymphatic relation with the pharynx, as suppurative otitis media, suppurative rhinitis, or suppurative cervical adenitis. The more tangible causes are caries of the vertebræ, the burrowing of pus, traumatism and the presence of foreign bodies in the pharynx. In adult subjects the pathological process is the same that characterizes the formation of an abscess in any other part of the body. The abscess is situated



in the cellular tissue in front of the bodies of the vertebræ, projects forward and generally lies to one side of the median line.

The development of the disease in the child is often masked and until some objective symptom is manifest the physician is at a loss to account for the existing malady. There are peculiar disturbances of the voice, cough, dyspnea and difficulty in swallowing. The child declines its food, rapidly loses flesh, is feverish, fretful and sleepless. An examination of the throat will reveal a swelling that projects forward in the pharynx, and is fluctuating to the touch.

**TREATMENT.** The pus should be evacuated immediately upon its recognition. The incision should be made at the most dependent point, to insure free and perfect drainage. If the patient is a child, nervous and uncontrollable, an anesthetic may be administered. If the morbid process extends from a glandular suppuration in the neck an external opening is demanded and drainage should be secured from this point. The evacuation of a large quantity of fluid in the pharynx may cause suffocation; therefore the child's head should be amply depressed. When diseased vertebræ are the cause of the abscess, exfoliations of bone may, at times, be discharged. Circumstances may arise in which a tracheotomy will be necessary to relieve severe dyspnea. After the pus has been evacuated a diligent investigation as to the origin of the disease should be made and the condition treated.

Caries arising from diseased vertebræ usually proves fatal. Since a majority of such patients are of a strumous diathesis a restorative treatment must be instituted. A nutritive diet and cod liver oil should be ordered and such remedies prescribed as calcarea iod., calcarea phos., calcarea baryta, arsenicum iodatum, mercurius iodatus, hepar sulphur, etc.

#### **Removal of Tumors or Foreign Bodies from Pharynx.**

—In removal of a tumor or foreign body from the pharynx it will, at times, become necessary to adopt some of the external methods of operating. The situation and character of the growth will have much to do with shaping the operative procedure. In most cases, however, the natural outlet will afford sufficient space to accomplish the result, or at least a simple incision of the cheek up to the border of the masseter muscle will suffice. When malignant diseases have extensively invaded the region, or other conditions exist that require greater space for their management, some form of pharyngotomy must be adopted.

**Sub-hyoid Pharyngotomy.**—Malgaigne and Vidal de Cassis proposed this method of operating for diseased conditions of the pharynx at about the same time, though Pratt, of the French navy, was the first to successfully put it into practice. The operation is to be commended in growths situated low down on the pharyngeal walls.

**OPERATION.** "The patient should be placed on a table with the shoulders elevated, as in tracheotomy, the head being bent backward as far as possible. A transverse incision through the integument is made about one-third of an inch below the lower border of the hyoid bone, extending from the anterior border of the sterno-mastoid muscle on one side to a similar point on the opposite side (Fig. 566). The skin and superficial fascia are incised; in the latter course the anterior and occasionally the external jugular veins. These are to be included between double ligatures and severed. Beneath the superficial fascia the sterno-hyoid muscles



are met with in the median line, one on either side, and cut through; and beneath these the thyro-hyoid muscles, which are treated in the same manner. The thyro-hyoid membrane is then reached,

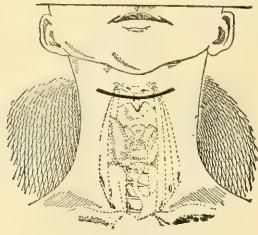


Fig. 566.  
Cutaneous Incision in  
Sub-Hyoid Pharyngotomy,  
and the Relation of the  
Deeper Parts.

dense in the median line, but becoming more attenuated laterally. The wound should be now explored by the thumb and index finger and the attempt made to ascertain the position of the epiglottis. When this is found the thyro-hyoid membrane and the pharyngeal mucous membrane, which is beneath it, should be incised at the side of the epiglottis and the incision carried directly through to the opposite side. This will be done cautiously, to avoid wounding either the epiglottis or its attachments. The crest of the epiglottis is now seized and drawn out through the wound,

when a stout thread should be passed through it and a loop formed; it is then drawn downward and forward by an assistant, in such a way as to leave wide and free access to the pharyngeal cavity. If now upon direct examination and palpation of the growth which has called for the operation, it is found to extend downward into the esophagus, a special advantage of the procedure lies in the fact that more space can be gained by extending the end of the incision on one or the other side down along the border of the sterno-mastoid muscle in such a way as to convert the procedure practically into a lateral pharyngotomy, or more correctly, perhaps, an esophagotomy.

“After the growth has been removed, the wound is closed by inserting sheep-gut sutures into the thyro-hyoid membrane and the severed muscles, and finally bringing together the cutaneous flaps and treating them in a similar manner.

“The patient should now be restricted to rectal alimentation for at least forty-eight hours.”

**Lateral Pharyngotomy.**—LANGENBECK'S METHOD. “A curved incision (see Fig. 567) is made through the integument, which, commencing at the lower border of the inferior maxilla, midway between the chin and angle, passes downward to the superior cornu of the hyoid bone and along the anterior border of the sterno-mastoid muscle to a point opposite the cricoid ring, or lower if necessary. Immediately beneath the integument the platysma muscle, lying in the superficial fascia, is divided. Beneath this is found the deep cervical fascia which is to be incised with some care, especially in the upper portion where important vessels and nerves may be encountered. In the lower portion of the wound, however, the only vessel which may be met with is the superior thyroid; this should be avoided, while the sheath of the great vessels is retracted. Beneath the deep fascia in the upper portion of the wound the sub-maxillary gland is seen and pushed to one side, when the hyoglossus muscle comes into view and is severed, and the lingual artery which courses beneath it is sought for and ligated.



Fig. 567.  
Line of Cutaneous  
Incision in Lateral  
Pharyngotomy. Langenbeck's Method.

After this the stylo-hyoid and digastric muscles are severed and the greater cornu of the hyoid bone is found, beneath which lies the pharyngeal aponeurosis; this being incised with the mucous membrane beneath it the pharyngeal cavity is reached. When the pharynx is opened the incision through its lateral wall may be extended as far up as the base of the tongue and down to the orifice of the esophagus, thus obtaining a wide access to this region for the carrying out of the indications for which the operation is done. This method is especially valuable for the removal of tumors involving the lower portion of the pharynx and even extending into the esophagus, in that this latter structure can be opened through a considerable portion of its upper extremity. Moreover, by strongly retracting the anterior flap the posterior wall of the larynx is brought thoroughly within reach; and where this has been invaded by the morbid process its resection is easily accomplished."

**KUSTER'S METHOD.** In a case of malignant disease involving the pharynx, palate and faucial pillars, this surgeon performed the following operation.

"A cutaneous incision, commencing at the angle of the mouth, was carried backward across the angle of the jaw to the anterior border of the sterno-mastoid muscle (See Fig. 568). The cheek was completely cut through, some small branches of the facial artery being encountered and ligated; the ramus of the jaw was then exposed and sawed through in the line of incision. The upper fragment was then disarticulated and removed. The incision was carried through the mucous membrane back as far as the border of the sterno-mastoid muscle. By depressing the jaw and retracting the upper flap, abundant access was obtained to the faucial region and cavity of the pharynx."



Fig. 568.  
Line of Cutaneous  
Incision in Lateral  
Pharyngotomy.—Kuster's Method.

The same surgeon suggests "that, in case the disease extends downward toward the esophagus, the horizontal incision might be made from the corner of the mouth to the angle of the jaw and then continued vertically downward to the border of the sterno-mastoid muscle, the upper fragment of the jaw being removed in the same manner as in his first operation."

**MICKULICZ' METHOD.** In this operation an incision is made through the integument of the side of the neck, extending from the mastoid process along the anterior border of the sterno-mastoid muscle down as far as the thyroid cartilage (see Fig. 569). The integument and superficial fascia being cut through, the deep fascia is reached, after which the dissection should be made with exceeding great care. Beneath this we come upon the great vessels, which are to be retracted. The facial artery should now be sought for and ligated, and the hypoglossal nerve carefully avoided. The anterior flap is retracted, and the angle of the jaw sought for and cleared. The periosteum of the ascending ramus is carefully separated, care being taken to preserve the insertion of the pterygoid



Fig. 569.  
Line of Cutaneous  
Incision in Lateral  
Pharyngotomy.—Mickulicz' Method.

muscles. The ramus is then sawn through and disarticulated. The lower portion of the incision is now deepened, the posterior belly of the digastric muscle divided, the stylo-hyoid drawn forward, and the lateral wall of the pharynx thus reached, which is opened in its whole extent from a point opposite the soft palate down as far as the esophageal entrance, if necessary.







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